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FLUORSPAR AND FLUORINE IN BRITISH COLUMBIA

By Jennifer Pell

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TABLE OF CONTENTS

page

INTRODUCTION 1
Fluorspar - Uses and Economic Considerations 1
Method of Study 3

MAJOR FLUORSPAR DEPOSITS IN SOUTHERN BRITISH COLUMBIA 5
Rock Candy Mine 5
History 5
Geology 5
Rock Geochemistry 6
Stream Water and Silt Geochemistry 6
Age and Genesis 8
Economic Considerations 11
Rock Canyon Creek (Deep Purple) 11
History 11
Geology 11
Rock Geochemistry 13
Stream Water and Silt Geochemistry 15
Age and Genesis 15
Economic Considerations 15
Rexspar 19
History 19
Geology 19
Rock Geochemistry 20
Stream Water and Silt Geochemistry 23
Age and Genesis 23
Economic Considerations 23
Eaglet 27
History 27
Geology 27
Rock Geochemistry 31
Stream Water and Silt Geochemistry 31
Age and Genesis 31
Economic Considerations 31

MAJOR FLUORSPAR DEPOSITS IN NORTHERN BRITISH COLUMBIA 33
Liard Fluorite 33
History 33
Geology 33
Rock Geochemistry 37
Stream Water and Silt Geochemistry 37
Age and Genesis 37
Other Related Deposits 40
Economic Considerations 40

OTHER FLUORSPAR OCCURRENCES IN SOUTHERN BRITISH COLUMBIA 41
Significant Mineralization 41
Gypo, Oliver Silica 41
Whiteman Creek 41
Galena Farm 41
Redbird 43

page

Rock Geochemistry 44
Other Areas 44

AREAS WITH MINOR OR TRACE FLUORSPAR ASSOCIATED WITH OTHER TYPES OF MINERALIZATION 47
Carmi-Beaverdell Area 47
Ainsworth Area 47
Kechika Area 56

EVALUATION OF REGIONAL GEOCHEMICAL SURVEY FLUORINE-IN-WATER DATA, SOUTHERN BRITISH COLUMBIA 59

DISCUSSION AND CONCLUSIONS 61

ACKNOWLEDGMENTS 63

REFERENCES 65

APPENDIX 1 67

FIGURES

1. Fluorspar occurrences in British Columbia 2
2. Fluorspar in British Columbia . . . . . *(in pocket)*
3. Producers and consumers of fluorspar in North America, 1988 3
4. Fluorine in the Penticton area . . . . . *(in pocket)*
5. Fluorine in the Nelson area . . . . . *(in pocket)*
6. Fluorine in the Lardeau area . . . . . *(in pocket)*
7. Fluorine in the Vernon and Ashcroft areas . . . . . *(in pocket)*
8. Fluorine in the Seymour Arm and Bonaparte Lake areas . . . . . *(in pocket)*
9. Fluorine in the Quesnel Lake area . . . . . *(in pocket)*
10. Geology of the Rock Candy mine area 6
11. Fluorine-in-water and silts, Rock Candy mine area 9
12. Geology of the Rock Canyon Creek fluorite and rare-earth showing 12
13. Fluorine-in-water and silts, Rock Canyon Creek area 16
14. Generalized geology of the Rexspar property . . . 18
15. Fluorine-in-water and silts, Rexspar area 25
16. Geological map of the Eaglet prospect 26
17. Fluorine-in-water and silts, Eaglet area 28

18. Generalized geology of the Liard fluorspar showings 34
19. Fluorine-in-water and silts, Liard area 36
20. Geology and fluorine-in-water and silts, Mile 397 area 39
21. Geology and stream water and silt geochemistry, Silverton-Galena Farm area 42
22. Fluorine-in-water and silts, Beaverdell-Carmi area 48
23. Fluorine-in-water and silts, Ainsworth area 49
24. Fluorine-in-water and silts, Kechika area 57
25. Fluorspar occurrences as related to $^{87}Sr/^{86}Sr$ ratios 62

TABLES

1. Rock geochemistry, Rock Candy mine 7
2. Stream-water chemistry, Rock Candy mine area 10
3. Stream-sediment geochemistry, Rock Candy mine 10
4. Rock geochemistry, Rock Canyon Creek 13
5. Stream-water chemistry, Rock Canyon Creek ... 15
6. Stream-sediment geochemistry, Rock Canyon Creek 17
7. Rock geochemistry, Rexspar 22
8. Stream-water chemistry, Rexspar 24
9. Stream sediment geochemistry, Rexspar 24
10. Rock geochemistry, Eaglet mine 29
11. Stream-water chemistry, Eaglet mine 30
12. Stream sediment geochemistry, Eaglet mine 30
13. Rock geochemistry, Liard fluorite and Mile 397 barite 35
14. Stream-water chemistry, Liard Hotsprings area .. 37
15. Stream-sediment geochemistry, Liard Hotsprings 37
16. Stream-water chemistry, Mile 397 barite 38
17. Stream-sediment geochemistry, Mile 397 area .. 38
18. Stream-water chemistry, Galena Farm area 41
19. Stream-sediment geochemistry, Galena Farm 43
20. Rock geochemistry of selected fluorite showings 45
21. Rock geochemistry of selected samples from the Beaverdell and Ainsworth areas 50
22. Stream-water chemistry, Beaverdell-Carmi area 51
23. Stream-sediment geochemistry, Beaverdell-Carmi area 51
24. Stream-water chemistry, Ainsworth area 52
25. Stream-sediment geochemistry, Ainsworth area 52
26. Rock geochemistry, Kechika yttrium and rare-earth prospect 53
27. Stream-water chemistry, Kechika area 56
28. Stream-sediment geochemistry, Kechika area ... 58

PLATES

1. Drusy openings in silica-cemented brecciated fluorspar, Rock Candy mine 8
2. Fluorite forming the matrix of a limestone breccia, Devonian Fairholm Group Rocky Canyon Creek 14
3. Fluorite, and possibly minor barite, forming the matrix of a limestone breccia, Rock Canyon Creek 14
4. Lithic tuff extensively replaced by fluorite, Rexpar deposit 20
5. Layered, pyrite-rich ore, A zone, Rexpar deposit 21
6. Mineralized fragmental rock, A zone, Rexpar deposit 21
7. Sheared lithic tuff, A zone, Rexpar deposit 21
8. Dark purple fluorite and coarsely crystalline barite blades, Mile 397 barite occurrence 38
9. Radiating texture in pale green fluorite, Whiteman Creek 43
10. Crystalline purple fluorite and banded chalcedonic quartz; epithermal vein, Redbird property 44

APPENDIX

FLUORSPAR OCCURRENCES IN BRITISH COLUMBIA 69

INTRODUCTION

Fluorspar is the commercial name for the mineral fluorite, CaF_2. It is a transparent to translucent mineral which often occurs in well-formed crystals ranging in colour from white to amber, green, blue, purple and black. It was used by the early Greeks and Romans for ornamental purposes, carved into vases, drinking cups and tabletops. The name fluorite is derived from the Latin word *fluere*, to flow, and refers to its low melting point and its use in metallurgy as a flux, which has been known since the sixteenth century (Fulton and Montgomery, 1983).

Fluorite forms in a wide range of temperature and pressure conditions and therefore occurs in many geologic environments. It may be associated with calcite and barite in low-temperature, carbonate-hosted lead-zinc deposits; with quartz in granite-related silver-lead-zinc veins; with chalcedonic quartz and gold in epithermal vein systems; and with silver and lead in manto-type replacement deposits in carbonate rocks adjacent to granitic intrusions. Fluorine is also often enriched in carbonatites and related alkaline rocks, in specialized granites and complex pegmatites, and in skarns and greisens; consequently fluorite and other fluorine-bearing minerals are often associated with tungsten, tin, uranium, rare earth and "high tech" metal (yttrium, niobium, tantalum, beryllium, zirconium *etc.*) deposits related to these rock types.

Fluorine is a useful pathfinder element for a wide range of deposit types; fluorite itself has commercial importance, largely in the metallurgical and chemical industries. Mexico and China currently rank as the world's largest suppliers of fluorspar, together accounting for approximately 30 per cent of world production. The Soviet Union, South Africa, Spain, Italy, France, Great Britain and Thailand are also significant producers. The United States is the world's major consumer of fluorspar and a former significant producer.

Fluorite occurrences are widespread throughout British Columbia. Fluorite has been found associated with mineral deposits in numerous geologic environments and in all tectonic belts except the Insular Belt [Figure 1 and Figure 2 (in pocket)]. There are five major fluorite prospects and, though none are currently receiving any significant attention, one deposit, the Rock Candy mine, has a history of past production. A number of other deposits in the province also contain significant concentrations of fluorspar. This report describes known occurrences and outlines the geological environments in which they are found. The properties described are strictly examples and may be used as models or guides in exploring for new, potentially economic showings.

FLUORSPAR - USES AND ECONOMIC CONSIDERATIONS

Fluorspar is marketed in three major grades - acid, ceramic and metallurgical. Acid grade fluorspar contains no less than 97 per cent CaF_2 and user-specified limits on silica (generally less than 1 per cent), calcium carbonate (generally less than 1 per cent), arsenic (10 to 12 ppm or less is preferred), lead, sulphide sulphur and phosphorus (preferably less than 550 ppm or 0.055 per cent, Clarke, 1987). Acid grade fluorspar is used in the production of hydrofluoric acid. Hydrofluoric acid is used to manufacture synthetic cryolite which is required in aluminum production; to make organic and inorganic fluoride chemicals which have such diverse uses as aerosol propellants (*e.g.* fluorocarbons), refrigerants, plastics, films and elastomers, solvents, dielectrics and lubricants; in water fluoridation; and to produce elemental fluorine which is used in the production of nuclear fuels. The acid itself is also important in steel pickling, enamel stripping, glass etching and polishing, various electroplating operations and in the manufacture of alkylate, an ingredient in high-octane aircraft and automobile fuels (Fulton and Montgomery, 1983; Gossling and McCulloch, 1974; Pelham, 1985).

Ceramic grade fluorspar is generally marketed in two classes; No. 1 Ceramic generally contains 95 to 96 per cent CaF_2 and No. 2 Ceramic comprises 85 to 90 per cent CaF_2. An intermediate grade of approximately 92 to 93 per cent CaF_2 is also produced. Impurity specifications vary, but commonly allow up to 3 per cent silica, 1.5 per cent calcite, 0.12 per cent iron oxide and traces of lead and zinc. Ceramic grade fluorspar is used to make flint glass, white or coloured opal glasses for ornamental glassware, enamels for covering stoves, refrigerators, bathtubs and cookware, and for facing bricks and tile. It is also used in the manufacture of magnesium and calcium metals, fibreglass insulation and as a clinkering aid in the production of portland cement (Fulton and Montgomery, 1983; Pelham, 1985).

Metallurgical grade fluorspar contains a minimum of 60 "effective" per cent CaF_2 and less than 0.3 and 0.5 per

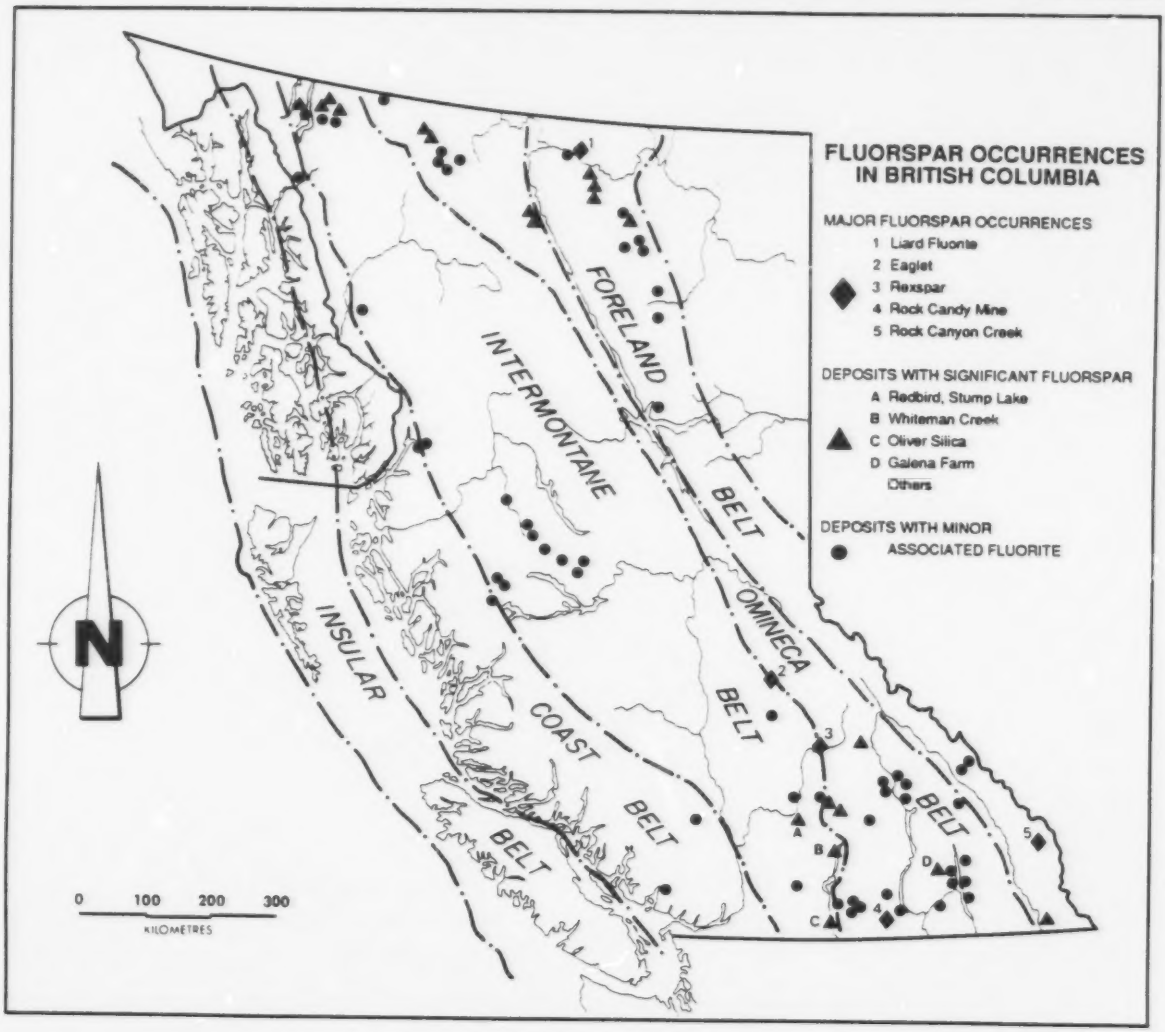


Figure 1. Fluorspar occurrences in British Columbia.

cent of sulphide sulphur and lead, respectively. The "effective" percentage is $\%CaF_2 - 2.5 \times \%SiO_2$. It is used as a fluxing agent in steel making; it reduces the surface tension of the slag, reduces variation in slag viscosity with melting temperature, lowers the melting point of the slag and improves the fluidity, and therefore the heat transfer of the slag (Fulton and Montgomery, 1983; Gossling and McCulloch, 1974; Pelham, 1985).

Economic grades vary depending on deposit type and mining method among other factors. Large, stratiform carbonate-hosted fluorite-barite-lead-zinc deposits in Illinois, Mexico and South Africa are mined with CaF_2 grades of 15 per cent and up. Mineable vein deposits generally contain 25 to 80 per cent or more of CaF_2. Fluorspar occurs as a major gangue mineral in many lead-zinc vein and replacement deposits and is economically recoverable, as a byproduct, when fluorspar grades are 10 to 20 per cent (Pelham, 1985).

The primary consumers of fluorspar are the chemical industry (approximately 42 per cent), the aluminum industry (21 per cent), both of which utilize acid grade spar, and the steel industry (31 per cent), which requires metallurgical grade fluorspar. Forecasts predict greater increases in demand for acid grade spar than for the lower purity products (Pelham, 1985). Approximately one-fifth of the world's fluorspar consumption goes into the production of fluorocarbons (part of the 42 per cent consumed by the chemical industry). This will be adversely affected, in the short term, by recent international agreements to limit production of certain environmentally unfriendly fluorocarbons in favour of ozone-friendly fluorocarbons and non-fluorocarbon based propellants (Roskill Information Services, 1988). The fluorspar mar-

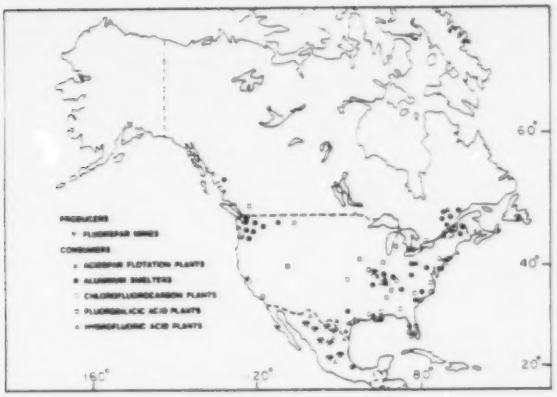


Figure 3. Producers and consumers of fluorspar in North America, 1988.

ket seems to be moving from several years of oversupply into better balance, and the market outlook is mildly positive. One market niche that appears to be developing is for very low arsenic, low-phosphorus acid spar (Metals Economics Group, 1988). Current fluorspar prices, as quoted in Industrial Minerals, January 1989, are approximately US$70-77 per tonne for metallurgical grade Mexican fluorspar, f.o.b. Tampico and US$115-120 per tonne for acidspar, f.o.b. source (northern Europe, Tampico or Durban, South Africa). Acidspar produced in Illinois sells for US$168-173 per short ton.

Canadian consumption of fluorspar (acidspar grade) is in the order of 170 000 tonnes per annum, of which approximately 110 000 tonnes are imported (Boucher, 1986; Dawson, 1985; Harben, 1985; Pelham, 1985, Prud'homme, 1988). The imports come from three main sources: Mexico supplies approximately half of the requirements, with Morocco, Spain and recently China contributing the balance. Italy is also an intermittent supplier. The United States consumes in excess of 400 000 tonnes of acidspar per annum, of which 390 000 tonnes are imported. The U.S. imports are mainly from Mexico and South Africa, which jointly account for more than 80 per cent of the total. Spain, Morocco, Italy, China and, since 1987, Canada also exports fluorspar to the United States. In addition, the U.S. imports approximately 104 000 tonnes of hydrofluoric acid per annum, predominantly from Mexico and Canada (Prud'homme, 1988, 1989). In North America, acidspar and acidspar product consumers are mainly located in the eastern United States, Texas, Ontario, Quebec and northern Mexico. In the western part of the continent, there is some production of chlorofluorocarbons in California, and aluminium smelting occurs in the northwestern U.S. and at Kitimat, British Columbia. (Figure 3).

In Canada, St. Lawrence Fluorspar Limited, at St. Lawrence, Newfoundland, is the only current fluorspar producer. This mine was reopened in 1987 and produces approximately 60 000 tonnes per annum of high-purity fluorspar concentrate (Clarke, 1987). Small amounts of fluorosilicic acid are produced as a byproduct of phosphoric acid at one phosphate fertilizer plant in western Canada. In the past, fluorspar was mined in the Madoc and Wilberforce areas of Ontario, at St. Lawrence, Newfoundland (from 1933 to 1978) and from the Rock Candy mine, north of Grand Forks, British Columbia (Dawson, 1985; Wilson, 1929). A small amount of fluorite (29.2 tonnes) was also shipped from the Gypo silica quarry at Oliver, British Columbia (McCammon and James, 1959).

METHOD OF STUDY

This project entailed the compilation of information on all known fluorspar prospects and occurrences in British Columbia (Figures 4 to 9 in pocket).

The purpose of this report is not to provide a comprehensive review of fluorspar in the province, but rather to outline known occurrences and environments and provide a guide for further exploration. Five major prospects, a number of significant showings, and some mineralogical occurrences were visited, mapped and sampled in detail. Water and silt samples were also taken in these areas in order to characterize their geochemical signatures and allow comparison with the results of Regional Geochemical Surveys (RGS). Due to the favourable economic potential of properties close to transportation and markets, there is a heavy emphasis on the southern part of the province. Fluorine-in-water data from the Regional Geochemical Surveys for the southern part of the province (NTS 82E, 82F, 82K, 82L, 82M, 92H E1/2, 92I E1/2 and 93A) were statistically analyzed in order to define threshold values which separate background from anomalous populations for catchment basins underlain by different rock types. The PROBPLOT program written by Stanley (1987) was used to determine these threshold values. The Regional Geochemical Survey fluorine anomalies are assessed, comparisons between areas of anomalous fluorine-in-water values and known fluorspar occurrences are made, and methods for using the fluorine data in regional prospecting are suggested.

MAJOR FLUORSPAR DEPOSITS IN SOUTHERN BRITISH COLUMBIA

ROCK CANDY MINE

MINFILE No. 082ESE070

The Rock Candy fluorspar property is located on Kennedy Creek, approximately 27 kilometres north-northwest of Grand Forks, at the south end of the Omineca Belt, latitude 49°14'N and longitude 118°29'W. The main showing is exposed between 790 and 880 metres elevation, on the wooded slopes north of Kennedy Creek. It can be reached by a forest access road which branches off the North Fork road approximately 19 kilometres north of Grand Forks, follows Pass Creek westerly for 3.5 kilometres and then follows Rock Candy Creek, north for approximately 8.5 kilometres to Kennedy Creek.

HISTORY

The deposit was discovered in 1916 by two prospectors who mistook the green fluorite for a copper-bearing mineral (Dolmage, 1929). The property was acquired by Consolidated Mining and Smelting Company of Canada, Limited (Cominco) in 1918. Once the true nature of the mineralization was realized it was immediately put into production. It was in operation intermittently between 1918 and 1929, and a total of 51 495 tonnes of ore with an average grade of 68 per cent CaF_2 and 22 per cent SiO_2 was mined. The mine operated through two adits; all mining was carried out using shrinkage stoping (Parsch, 1973). The ore was transported by aerial tramway to the Granby River valley, approximately 4 kilometres east of the minesite, and from there to the Trail smelter where most of it was used (Dolmage, 1929). The adits remained open until the early 1980s at which time they were blasted closed. It is estimated that approximately 12 300 tonnes of broken ore remain in the stopes and that 47 800 tonnes of probable ore remain in pillars and sills in and adjacent to stoped areas (Parsch, 1973). The mine was controlled by Cominco until its recent acquisition by a mineral collector.

GEOLOGY

The Rock Candy fluorspar deposit consists of an intricate network of subparallel veins, which vary from a few centimetres to approximately 10 metres in width. They occupy a silicified, northerly-trending, moderate to steeply west-dipping fracture zone in Tertiary andesitic volcanics adjacent to a large syenitic intrusion (Figure 10). Fine-grained syenite dikes crosscut the andesites in the vicinity of the deposit (Parsch, 1973). Within the mine the veins were numerous and extremely close spaced, with only narrow bands and isolated horses of altered country rock between them (Dolmage, 1929). The developed mineralized zone extends for approximately 200 metres north from Kennedy Creek and has a maximum width of 15 metres. The vein reappears in outcrop about 1 kilometre north of the main developed zone (Figure 10).

Andesites which host the fluorite veins are predominantly fine to medium grained, greenish to grey in colour and contain albite, oligoclase and actinolite with minor magnetite and biotite. Quartz occurs as veinlets and cavity fillings. Sericite, calcite and chlorite are locally developed alteration minerals (Dawson, 1985; Parsch, 1973). Immediately adjacent to the veins, the andesites are strongly altered, weather to a pinkish buff colour, and contain chlorite, sericite, quartz, calcite, pyrite and abundant clay minerals including kaolin (Parsch, 1973; Dolmage, 1929). These rocks are correlative with the Marron Formation of Paleocene or Eocene age. Outcropping to the east of the vein system are medium to coarse-grained, massive pink syenites which have been correlated with the Paleocene to Eocene Coryell intrusions (Dawson, 1985; Little, 1957). The syenites contain large pink and green feldspar crystals, predominantly orthoclase, with minor plagioclase. The centres of some orthoclase crystals have been identified as hyalophane, a barium-rich orthoclase (Dolmage, 1929). Biotite, hornblende, augite and magnetite, and traces of quartz, apatite, sphene and zircon are also present in the syenite. The ferromagnesian minerals are commonly altered to chlorite, and epidote is locally present (Dawson, 1985; McCammon, 1968a; Parsch, 1973). Microsyenite dikes locally crosscut the andesites and the coarse-grained intrusion. The dikes consist mainly of altered feldspars with some interstitial quartz and secondary calcite and chlorite. Fluorite has been reported from one such dike (Dolmage, 1929). Granite and granodiorite, correlative with the Early Cretaceous Nelson batholith, are exposed south of Kennedy Creek.

Excellent surface exposures of a large vein exist near the old workings, the eastern margin of which is covered

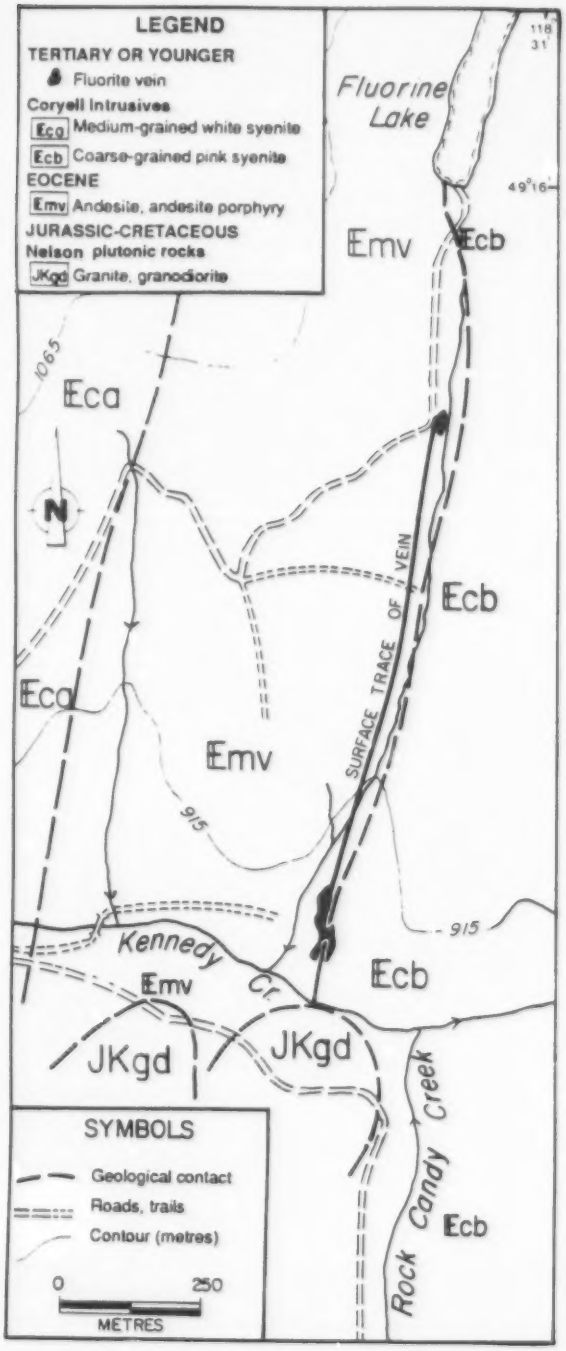


Figure 10. Geology of the Rock Candy mine area compiled from work by Cominco Ltd. and mapping by Pell (Pell and Fontaine, 1989).

in till. The outcrop consists of a 3 to 4-metre width of predominantly massive fluorite, bordered to the west by 1.5 to 2 metres of fluorite-matrix breccia and a thin composite-banded margin adjacent to altered volcanic country rocks. The massive portion of the vein consists of coarse-grained, pale apple to emerald green fluorite and minor pale purple fluorite cut by numerous vuggy quartz veins. Within the mine, numerous large vugs have been reported which are locally in excess of 1 metre in size, lined with crystals of barite, quartz, calcite and fluorite or containing white kaolin (Dolmage, 1929). The marginal breccia zone contains subangular, altered fragments of volcanic country rock in a matrix of purple and green fluorite, chalcedony, kaolin, pyrite, quartz and calcite. The banded western margin of the vein comprises both crystalline and massive, banded barite with calcite, fluorite, chalcedony and quartz. Chalcopyrite, galena, chalcocite and covelite have been reported by early workers (Freeland, 1920) but are not evident in outcrop. Numerous fluorite veinlets, 4 to 5 centimetres thick and subparallel to the main vein, cut the altered volcanic rocks.

Approximately 1 kilometre north of the main showing, the fluorite mineralization is again exposed in outcrop. In this area a vein, 1 metre wide, cuts altered volcanics. It consists of massive, pale purple and pale green fluorite cut by quartz veins and a breccia a few centimetres across, consisting of angular fluorite fragments, in a matrix of small quartz crystals. Small vugs lined with quartz crystals are abundant (Plate 1). A significant linear structure connects this showing with the main workings and extends for some distance to the north and south. Drilling has indicated that fluorite mineralization is intermittently developed along the fracture zone, however, no economic grades were reported any distance from the main workings (Parsch, 1973).

Rock Geochemistry

Hand-cobbed fluorspar samples from veins at the Rock Candy mine generally contain between 37 and 42 per cent fluorine, or correspondingly 76 to 87 per cent CaF_2 (RC88-1A, 1A-D, 1B, Table 1), 2 to 12 per cent silica and approximately 100 ppm phosphate. Material collected from vein margins is highly variable, containing 13 to 28 per cent fluorine, or between 27 and 58 per cent CaF_2, 25 to 65 per cent silica and 200 to 500 ppm P_2O_5 (RC88-1C, 7A and 7B, Table 1). All material collected assayed low in strontium, yttrium and rare earths.

Stream-water and Silt Geochemistry

Stream-water and silt samples were collected in the immediate vicinity of the Rock Candy mine. Values greater than 110 ppb fluorine in waters and greater than 900 ppm fluorine in silts appear to be indicative of nearby

TABLE 1
ROCK GEOCHEMISTRY, ROCK CANDY MINE

SAMPLE NO.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	F	CaF_2
RC88-1A	11.72	0.01	0.46	0.53	<0.01	0.16	56.76	0.18	0.06	0.01	4.01	37.31	76.66
RC88-1B	1.97	0.01	0.33	0.51	<0.01	0.15	64.72	0.22	0.04	0.01	0.78	40.96	84.16
RC88-1C	25.05	0.05	3.55	0.96	<0.01	0.26	40.31	0.18	0.79	0.04	6.91	28.16	57.86
RC88-1D	72.70	0.17	12.71	2.39	0.02	0.59	4.59	0.17	3.66	0.12	3.82	2.75	5.65
RC88-1E	1.49	0.01	0.39	0.54	<0.01	0.14	4.29	0.16	0.04	0.01	1.22	2.12	4.36
RC88-3	69.41	0.31	14.27	2.78	0.06	0.46	3.40	2.59	3.49	0.13	4.76	0.07	0.14
RC88-4	58.81	0.75	18.01	4.27	0.07	1.38	2.71	3.70	5.54	0.34	3.55	0.12	0.25
RC88-5	63.57	0.38	16.42	3.25	0.10	0.70	2.23	4.38	6.21	0.18	2.33	0.07	0.14
RC88-6	71.89	0.31	14.41	2.31	0.01	0.67	0.68	0.21	5.31	0.15	3.01	0.11	0.23
RC88-7A	39.40	0.01	2.08	0.54	<0.01	0.31	36.48	0.15	0.01	0.02	4.53	23.68	48.66
RC88-7B	64.38	0.07	3.85	0.82	0.01	0.33	18.65	0.18	0.62	0.05	4.78	13.44	27.62
RC88-8	53.91	0.85	16.84	7.12	0.14	3.06	6.40	2.72	4.09	0.48	4.03	0.18	0.37
RC88-1A-D	11.77	0.01	0.54	0.54	<0.01	0.16	57.12	0.18	0.07	0.01	3.08	42.37	87.06

SAMPLE NO.	Ba	La	Ce	Y	Th	U	Sr
RC88-1A	1244	100	79	15	29	44	174
RC88-1B	1102	123	118	108	23	45	516
RC88-1C	37000	141	280	67	<5	27	457
RC88-1D	1533	15	44	17	12	38	175
RC88-1E	610000	*	*	10	*	*	1323
RC88-3	1807	20	70	14	<5	26	390
RC88-4	2557	72	141	26	15	28	776
RC88-5	959	69	145	26	<5	36	569
RC88-6	1318	90	174	18	7	30	129
RC88-7A	68	45	53	10	17	46	105
RC88-7B	203	25	31	10	5	29	115
RC88-8	1831	77	139	30	21	35	1118
RC88-1A-D	2099	98	86	17	31	47	174

*Major element data in per cent, trace elements in ppm. *-Interference due to high barium. Sample descriptions as follows: RC88-1A purple fluorite; RC88-1B green fluorite; RC88-1C vein breccia consisting of altered volcanic rock fragments in a fluorite matrix; RC88-1D altered andesitic wallrock adjacent to the vein; RC88-1E barite-rich vein material from western vein margin; RC88-3 pink, altered volcanic rock near main vein; RC88-4 unaltered andesite; RC88-5 host syenite; RC88-6 felsic volcanic; RC88-7A fluorite-quartz vein breccia; RC88-7B mixed fluorite and volcanic rock from vein edge; RC88-8 andesite; RC88-1A-D duplicate of 1A, purple fluorite*

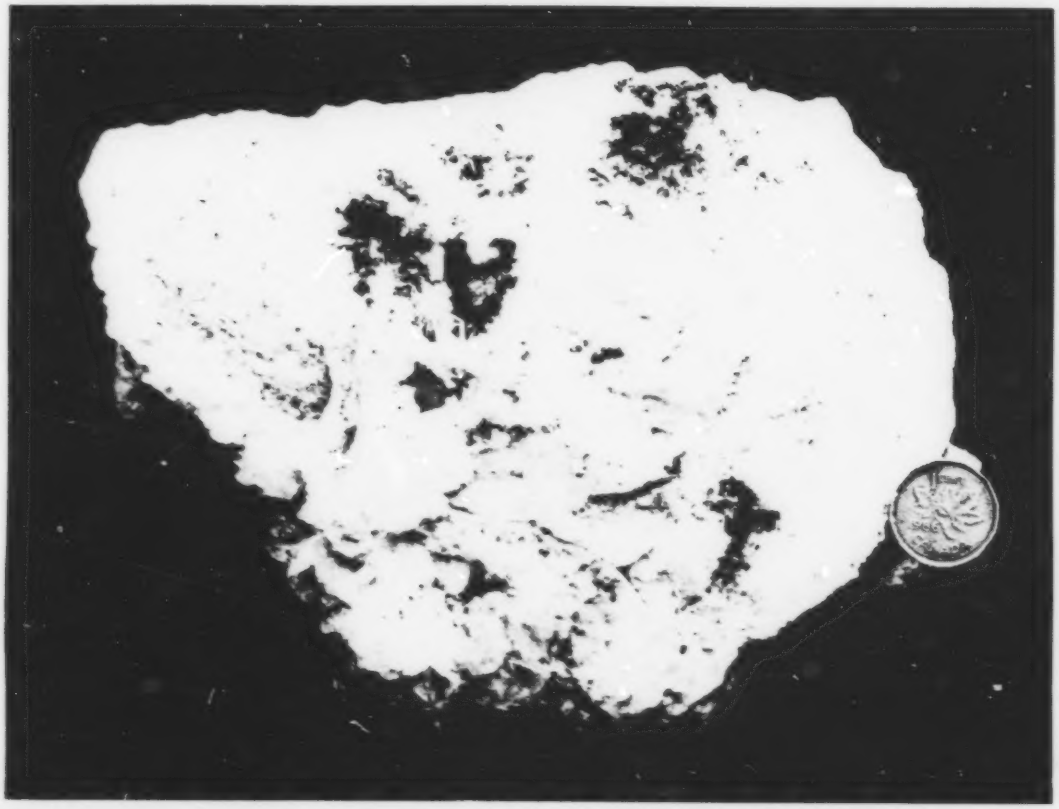


Plate 1. Crystalline quartz needles developed in drusy openings in silica-cemented brecciated fluorspar, from vein outcrop north of the Main showing.

mineralization (Figure 11, Tables 2, 3), however, the range in values is not great and anomalies are not well defined. Waters from Kennedy Creek, immediately downstream of the Rock Candy mine adits and dumps, do not appear to be enriched in fluorine; silts, however, do contain anomalous values. Silts taken downstream of fluorspar showings are also slightly enriched in lanthanum.

Statistical analysis of RGS fluorine-in-water data for NTS 82E (Figure 4) indicates that the threshold separating background from anomalous values for areas underlain by granitic and syenitic rocks is approximately 185 ppb, while threshold for areas underlain by Eocene andesites is approximately 450 ppb. Based on these values, only three water samples taken in the vicinity of the Rock Candy mine are anomalous for areas underlain by syenites and granites, and none are anomalous with respect to Eocene volcanic bedrock. The lack of obvious, well-defined, water anomalies downstream from the Rock Candy mine may, in part, be due to the lack of good outcrop of the fluorspar vein and the large-volume flow of Kennedy Creek.

AGE AND GENESIS

The Rock Candy deposit is an epithermal vein system occupying dilatant fissures in a north-trending fracture zone. Mineralization postdates the Paleocene to Eocene volcanic rocks in which it is hosted. Based on the fact that the Coryell syenite contains barium-rich feldspars and that fluorite had been found in related dikes, Dolmage (1929) suggested that the solutions from which the fluorspar veins were deposited were produced by fractionation and differentiation during the cooling and crystallization of the syenitic magma. A preliminary study of fluid inclusions has revealed that the inclusions are two-phase fluid-rich inclusions with uniformly small vapour bubbles. This suggests that the mineralizing fluids were low temperature and hydrothermal in origin, probably heated groundwater with no direct magmatic water component. In this case, the syenite may have contributed to mineralization in that hydrothermal fluids circulated through it acquired elements that were later deposited in the Rock Candy vein. Additional work is necessary to confirm this hypothesis.

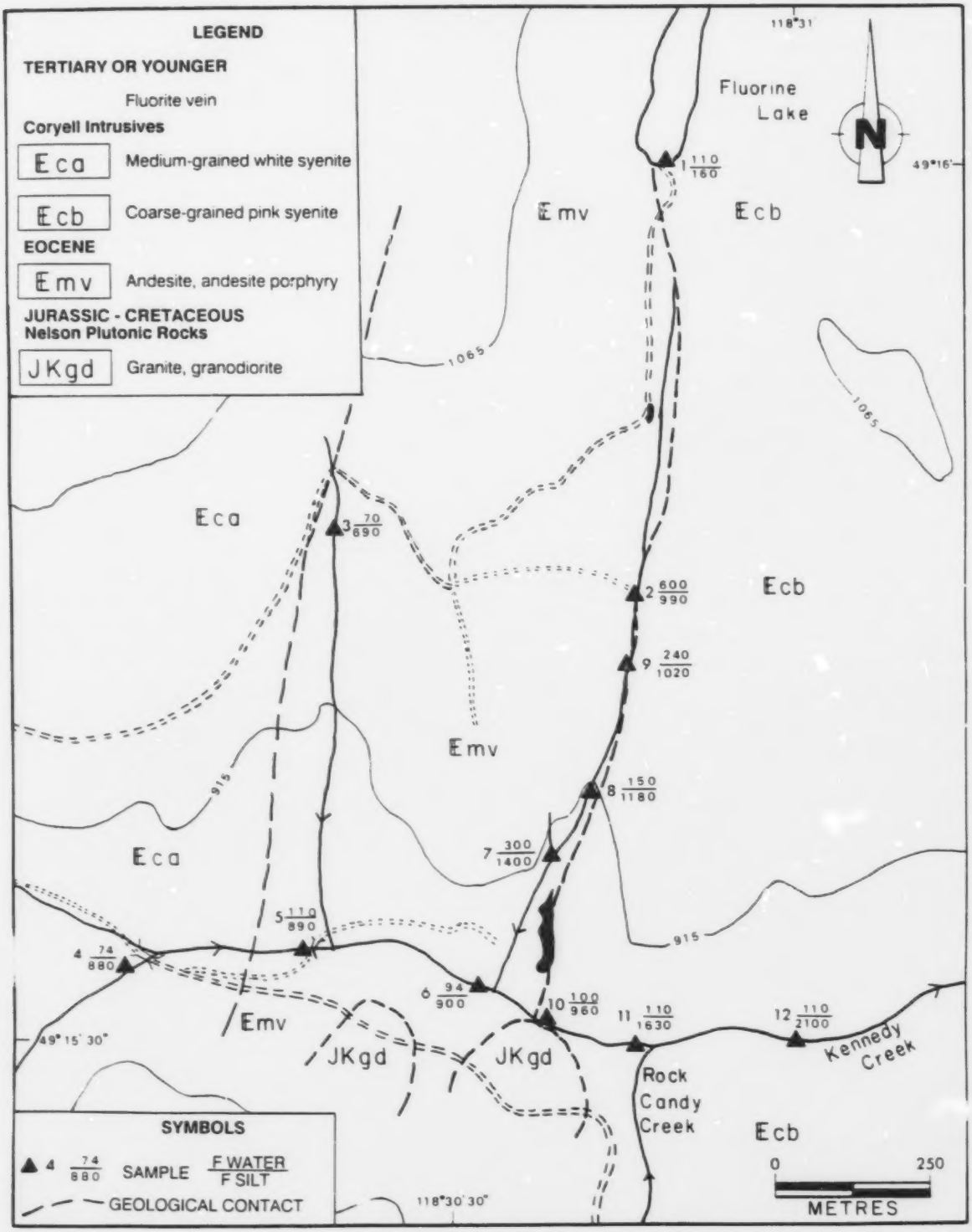


Figure 11. Fluorine-in-water and silts, Rock Candy mine area.

TABLE 2
STREAM-WATER CHEMISTRY,
ROCK CANDY MINE AREA

SAMPLE NO.	U ppb	F ppb	pH
82E/8-1	0.02	110	7.0
82E/8-2	0.7	300	7.4
82E/8-3	0.8	70	8.0
82E/8-4	0.14	74	7.2
82E/8-5	0.25	110	7.1
82E/8-6	0.22	94	7.1
82E/8-7	0.39	300	7.9
82E/8-8	0.63	150	7.6
82E/8-9	1.0	240	8.0
82E/8-10	0.2	100	7.3
82E/8-11	0.18	110	7.3
82E/8-12	0.17	110	7.3

TABLE 3
STREAM-SEDIMENT GEOCHEMISTRY,
ROCK CANDY MINE (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb
82E/8 S1	11	30	49	87	0.2	9	2	105	.78	4	5	0	2	481	1	3
82E/8 S2	2	69	30	88	0.3	41	10	456	3.02	2	5	0	9	157	1	2
82E/8 S3	1	33	24	74	0.2	13	7	611	2.88	2	5	1	1	186	1	2
82E/8 S4	1	9	18	57	0.1	9	6	366	3.44	2	5	0	14	32	1	2
82E/8 S5	1	9	16	72	0.1	12	6	386	4.00	2	5	0	16	32	1	2
82E/8 S6	1	6	16	48	0.1	11	6	267	3.36	2	5	1	15	31	1	2
82E/8 S7	1	27	31	83	0.3	21	8	866	2.86	3	5	0	4	84	1	2
82E/8 M7	1	46	22	85	0.2	40	8	2300	3.38	2	5	1	3	206	1	2
82E/8 S8	1	44	25	74	0.4	47	10	521	3.24	3	5	1	9	110	1	4
82E/8 S9	1	52	33	103	0.5	53	11	877	3.73	2	5	1	10	118	1	3
82E/8 S10	1	8	12	49	0.1	13	6	306	3.11	3	5	1	16	26	1	2
82E/8 S11	2	10	19	57	0.1	12	7	397	4.14	2	5	0	21	36	1	2
82E/8 S12	2	11	20	77	0.1	14	11	491	8.71	2	5	0	26	33	1	2

S denotes stream sediment, M denotes moss-mat sample

SAMPLE NO.	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
82E/8 S1	2	15	3.32	0.06	45	12	.18	143	0.02	6	1.04	0.01	0.03	1	160
82E/8 S2	2	37	1.08	0.06	288	68	.71	218	0.06	2	3.51	0.02	0.12	1	990
82E/8 S3	2	44	1.24	0.09	83	32	.55	228	0.05	2	1.97	0.01	0.09	1	690
82E/8 S4	2	68	.45	0.12	74	39	.28	40	0.07	2	0.87	0.01	0.04	1	880
82E/8 S5	2	79	.42	0.12	75	48	.27	40	0.08	2	0.70	0.01	0.05	1	890
82E/8 S6	3	65	.48	0.13	78	38	.24	37	0.07	2	0.70	0.01	0.04	1	900
82E/8 S7	2	35	.89	0.07	90	34	.50	135	0.03	2	1.89	0.01	0.12	1	1400
82E/8 M7	2	38	1.61	0.09	199	67	.77	288	0.04	2	3.03	0.01	0.16	1	940
82E/8 S8	2	41	.74	0.06	133	79	.83	217	0.06	3	3.49	0.01	0.13	1	1180
82E/8 S9	2	54	.78	0.08	182	90	.90	238	0.08	2	3.56	0.01	0.14	1	1020
82E/8 S10	15	59	.37	0.1	72	35	.25	29	7	6	.59	0.01	0.04	1	980
82E/8 S11	2	82	.56	0.13	86	48	.27	63	0.09	2	.78	0.01	0.08	1	1630
82E/8 S12	2	103	.69	0.17	107	103	.23	85	0.12	2	.83	0.01	0.05	1	2100

S denotes stream sediment, M denotes moss-mat sample

ECONOMIC CONSIDERATIONS

Fluorspar samples from the Rock Candy mine (Table 1, RC88-1A and B), which represent hand picked, apparently pure concentrates, contain less than 90 per cent CaF_2, and low phosphorus. Some benefication, possibly involving the removal of associated crystalline quartz, would be necessary to produce a marketable product. The low reserves, which are estimated to be approximately 60 000 tonnes (Parsch, 1973) do not suggest potential for renewed production.

ROCK CANYON CREEK (DEEP PURPLE)

MINFILE No. 082JSW018

The Rock Canyon Creek showing (Candy and Deep Purple claims) is located in the Main Ranges of the Foreland Belt, near the headwaters of Rock Canyon Creek approximately 40 kilometres east of Canal Flats, at 50°12'N, 115°08'W. It is accessible by conventional vehicles along the White River and Canyon Creek forestry roads, which join Highway 3A, 2 kilometres south of Canal Flats. The main mineralized zone lies between the 1525 and 2000-metre elevations in a valley that has been burnt-over and subsequently logged. Access is excellent, but exposure poor due to thick drift cover.

HISTORY

The prospect was discovered in 1977 during a regional exploration program carried out by Rio Tinto Canadian Exploration Limited in search of Mississippi Valley-type lead-zinc mineralization. Between 1977 and 1979, mapping, soil and rock geochemistry, and trenching were done to assess the fluorspar-lead-zinc potential of the property (Bending, 1978; Alionis, 1979). More recent work (Graf, 1981, 1985) attempted to establish the economic potential of the property in terms of other commodities. During this latter work it was discovered that the property also contained anomalous concentrations of rare-earth elements (REE). There has been no drilling on this property and the subsurface extent of mineralization is unknown.

GEOLOGY

The Rock Canyon Creek area is underlain by a Cambro-Ordovician to Middle Devonian carbonate-dominated sequence (Leech, 1979). The southwestern boundary of the property is marked by the easternmost in a series of west-dipping thrust faults which place Cambrian and Ordovician strata over younger rocks (Figure 12). The remainder of the area is underlain by an overturned to upright homoclinal sequence, younging to the east. This succession comprises coral-rich limestones of the Ordovician Beaverfoot Formation in the northwest, unconformably overlain by buff-weathering dolomites and solution breccias of the basal Devonian unit which are, in turn, conformably overlain by fossiliferous and nodular grey limestones of the Fairholm Group. The fluorspar and REE mineralization is stratabound, hosted mainly by the basal Devonian unit.

Four main types of fluorite mineralization are identifiable in the field (Pell and Hora, 1987). The first and most widespread consists of disseminations and fine veinlets of dark purple fluorite in a dark brown to dark orange-brown-weathering dolomitic matrix. Fluorite content generally varies from 2 to greater than 10 per cent of the rock and chemical analyses indicate CaF_2 values of 2.5 to 12.78 per cent (Graf, 1985). Bastnaesite ($CeCO_3F$) often occurs along the margins of fluorite veins, as does coarse crystalline dolomite. Disseminated pyrite, gorceixite [$(Ba,Ca,Ce)Al_3(PO_4)_2(OH)_3\ H_2O$], calcite, limonite, illite and barite are common accessory minerals (Hora and Kwong, 1986). Parisite [$CaCe_2(CO_3)_3F_2$] has also been identified from fluorite veins by scanning electron microscopy, and may be associated with bastnaesite. Neutron activation analyses of up to 2.3 per cent rare-earth elements and 2.7 per cent barium have been reported (Graf, 1985). Niobium, strontium and yttrium are also present in measurable amounts (Pell, 1987). Contacts between mineralized and unmineralized dolomitic rocks are gradational; the amount of fluorite veining decreases and the colour of the rocks changes gradually from dark brown to buff, the characteristic colour of unaltered dolomites in the area. This type of mineralization defines a northwest-trending zone mappable for over a kilometre, subparallel to strike (Figure 12).

The second type, and highest grade fluorspar mineralization, consists of massive, fine-grained purple and white fluorite which commonly comprises greater than 40 per cent of the rock, together with accessory prosopite [$CaAl_2(F,OH)_3$], gorceixite, pyrite and minor barite, calcite, rutile and kaolinite (Hora and Kwong, 1986). Chemical analyses (Graf, 1985; Pell, 1987) indicate CaF_2 contents for this type of mineralization between 24 and 71 per cent. The rare-earth element and pyrite contents are relatively low. Massive fluorite mineralization has not been found in place, but abundant float occurs at the southeast end of the zone of Type 1 mineralization, near the north-flowing branch of Rock Canyon Creek.

Fine-grained purple fluorite disseminated in white calcite, which is locally interbedded with buff-weathering dolomite and forms the matrix of solution breccias, constitutes the third type of mineralization. Fluorspar is present in concentrations from trace amounts to a few per cent. Minor enrichment in rare-earth elements is also reported (Graf, 1985). This type of mineralization is randomly distributed throughout the basal Devonian unit.

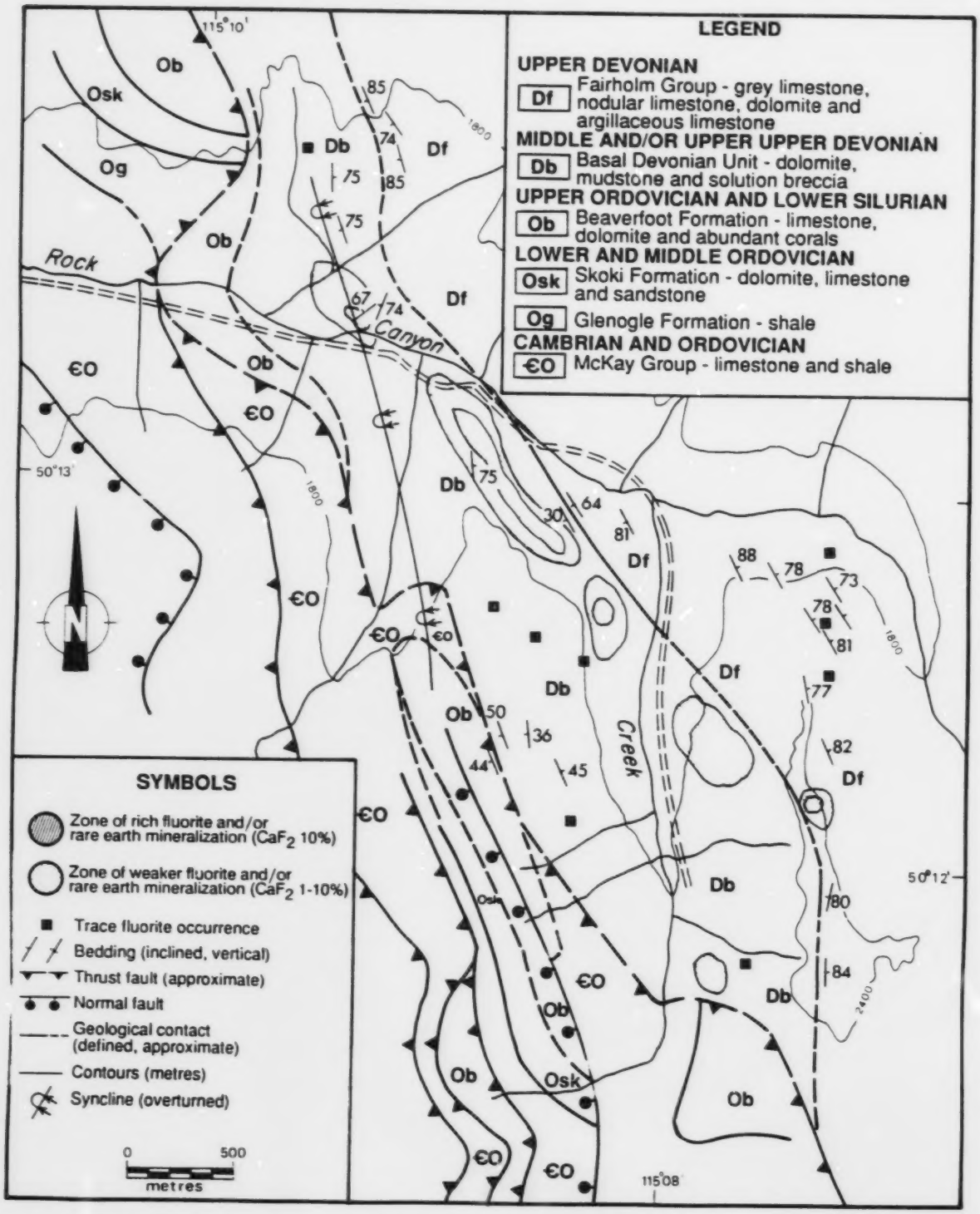

LEGEND
UPPER DEVONIAN
Df Fairholm Group - grey limestone, nodular limestone, dolomite and argillaceous limestone
MIDDLE AND/OR UPPER UPPER DEVONIAN
Db Basal Devonian Unit - dolomite, mudstone and solution breccia
UPPER ORDOVICIAN AND LOWER SILURIAN
Ob Beaverfoot Formation - limestone, dolomite and abundant corals
LOWER AND MIDDLE ORDOVICIAN
Osk Skoki Formation - dolomite, limestone and sandstone
Og Glenogle Formation - shale
CAMBRIAN AND ORDOVICIAN
€O McKay Group - limestone and shale
SYMBOLS
Zone of rich fluorite and/or rare earth mineralization (CaF_2 10%)
Zone of weaker fluorite and/or rare earth mineralization (CaF_2 1-10%)
Trace fluorite occurrence
Bedding (inclined, vertical)
Thrust fault (approximate)
Normal fault
Geological contact (defined, approximate)
Contours (metres)
Syncline (overturned)
0 500
metres
Rock Canyon Creek
115°10'
50°13'
50°12'
115°08'
N

Figure 12. Geology of the Rock Canyon Creek fluorite and rare-earth showings. Modified from Pell and Hora (1987) and Mott *et al.* (1986).

The fourth type of fluorspar mineralization occurs in rocks tentatively assigned to the Devonian Fairholm Group and is found in one locality, at the 2135-metre elevation on the ridge east of the headwaters of Rock Canyon Creek (Figure 12). Massive purple fluorite, which constitutes greater than 20 per cent of the rock, forms the matrix of an intraformational breccia and locally replaces the fragments (Plates 2, 3). Minor barite, pyrite and magnetite are also associated with this type of mineralization.

ROCK GEOCHEMISTRY

High-grade fluorite samples collected in the Rock Canyon Creek area contain approximately 32 to 35 per cent fluorine, or 65 to 71 per cent CaF_2 (DP6-37C, DP88-3, 4, Table 4), 6 to 9 per cent silica and high phosphorus (1400 to 16 700 ppm P_2O_5). These rocks are generally enriched in aluminum, calcium and barium, and depleted in magnesium and iron relative to altered hostrocks with rare-earth and minor fluorite mineralization. Samples

TABLE 4
ROCK GEOCHEMISTRY, ROCK CANYON CREEK

SAMPLE NO.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	F	CaF_2
DP86-23	22.79	0.10	2.25	1.29	0.02	11.79	26.84	0.21	1.17	0.04	27.78	6.08	12.94
DP86-37C	9.34	0.04	17.05	0.53	<0.01	0.17	42.08	0.18	0.05	0.17	12.88	33.28	68.38
DP86-08A	0.94	0.03	0.37	5.28	1.09	13.40	32.89	0.16	0.01	0.34	35.61	6.40	13.15
DP88-2	2.82	0.06	1.24	7.41	1.49	11.80	26.36	0.23	0.02	1.52	34.28	2.96	6.08
DP88-3	7.84	0.41	15.31	1.18	<0.01	0.22	39.59	0.24	0.13	1.67	12.02	32.00	65.75
DP88-4	6.39	0.02	17.16	0.64	<0.01	0.78	42.38	0.55	0.24	0.14	9.59	34.56	71.61
DP88-5	1.04	0.03	0.43	5.49	1.62	14.26	29.00	0.22	0.06	0.92	39.78	3.13	6.43
DP88-5	1.05	0.03	0.44	5.60	2.04	14.20	28.70	0.22	0.05	1.06	39.91	2.31	4.75

SAMPLE NO.	Ag	Mo	Cu	Pb	Zn	Co	Ni	Cr	Sn	W	Cs	Sc	Zr	Bi	V
DP86-23		20	25	40	42	4	<2	12	5	37	25	25.3	41	46	78
DP86-37C		14	115	177	54	2	3	10	251	18	46	46.9	23	8	76
DP86-08A		54	16	71	84	7	6	39	11	37	19	107.1	37	20	115
DP88-2	1	27	5	20	183										
DP88-3	11	29	82	150	147										
DP88-4	108	<8	72	152	79										
DP88-5	1	63	4	17	171										
DP88-5	1	67	3	23	200										

SAMPLE NO.	Ba	La	Ce	Yb	Y	Th	U	Rb	Sr	Nb	Ta
DP86-23	136	44	45	<3	21	76	38	40	300	63	<3
DP86-37C	13840	125	178	1	15	134	36	6	1129	48	5
DP86-08A	1306	5319	7858	4	165	412	40	26	1024	181	<3
DP88-2	14953	6072	8986		317	407			3723		
DP88-3	12215	530	948		163	460			>10000		
DP88-4	13582	111	142		17	45			1260		
DP88-5	950	3803	6302		146	263			1358		
DP88-5	960	3362	5625		127	223			1329		

Major elements in per cent; trace elements in parts per million. Sample descriptions as follows: DP86-23 intraformational limestone conglomerate with fluorite matrix; DP86-37C massive purple and white fluorite plus some calcite; DP86-08A fluorite veins in altered carbonate rock; DP88-2 fluorite and rare-earth mineralization in altered carbonate rock; DP88-3 purple fluorite; DP88-4 massive white and purple fluorite; DP88-5 fluorite and rare earth enriched, chocolate-weathering, altered carbonate rock.

Plate 2. Dark purple fluorite forming the matrix of a limestone breccia, Devonian Fairholm Group.

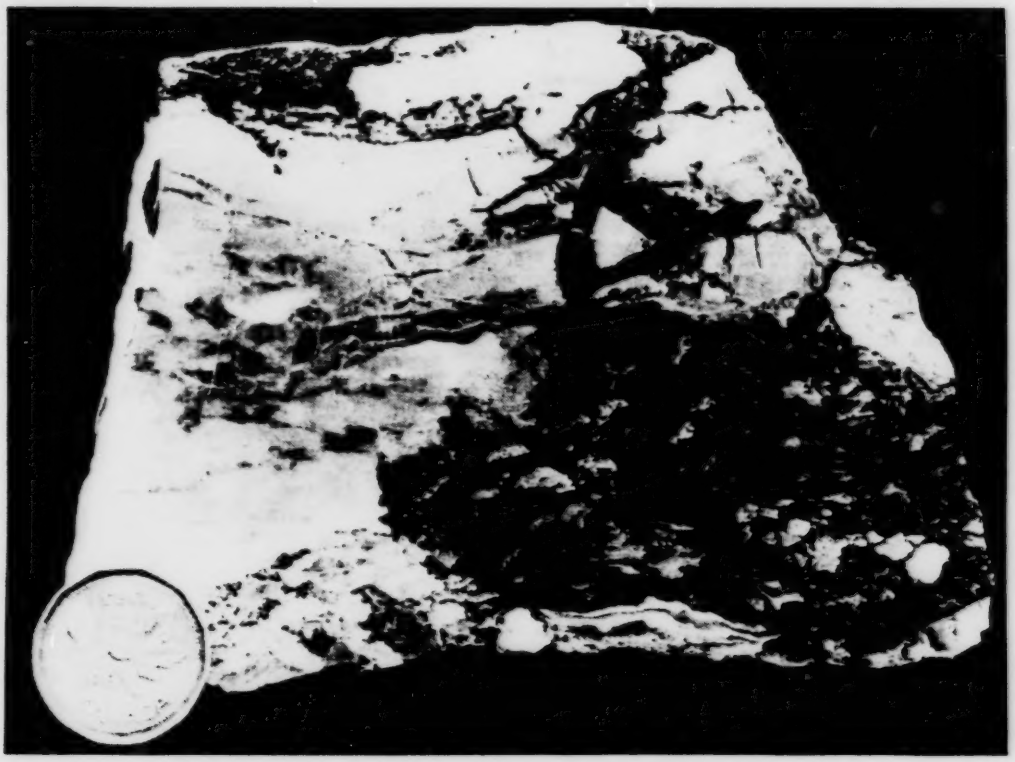


Plate 3. Dark purple and white fluorite and possibly minor barite forming the matrix of a limestone breccia, and in part replacing fragments.

TABLE 5
STREAM -WATER CHEMISTRY
ROCK CANYON CREEK

SAMPLE NO.	U ppb	F ppb	pH
82J/3-1	0.29	1000	8.3
82J/3-2	0.17	260	8.3
82J/3-3	0.22	800	8.4
82J/3-4	0.19	480	8.4
82J/3-5	0.2	490	8.2
82J/3-6	0.25	560	8.5
82J/3-7	0.26	1000	8.4
82J/3-8	0.23	600	8.5
82J/3-9	0.21	1100	8.5
82J/3-10	0.28	1330	8.2
82J/3-11	0.56	530	8.2
82J/3-12	0.48	820	8.2
82J/3-13	0.47	830	7.9
82J/3-14	0.55	820	8.0
82J/3-15	0.54	830	8.1
82J/3-16	0.45	570	8.5
82J/3-17	0.46	550	8.5
82J/3-18	0.49	520	8.1
82J/3-19	0.51	560	8.2
82J/3-20	0.46	550	8.4
82J/3-21	0.31	240	8.3
82J/3-22	0.41	560	8.1
82J/3-23	0.35	36	8.3
82J/3-24	0.54	490	8.3
82J/3-25	0.27	250	7.8
82J/3-26	0.31	210	8.3
82J/3-27	0.31	110	8.1
82J/3-28	0.31	110	8.3

assaying high in light rare-earths are also moderately enriched in yttrium and thorium. Strontium is enriched, locally comprising in excess of 1 per cent, in all mineralized rocks from the Rock Canyon Creek area except the fluorite-cemented intraformational breccias.

STREAM-WATER AND SILT GEOCHEMISTRY

Stream waters, sediments and moss-mat samples were collected in the Rock Canyon Creek area (Figure 13, Tables 5, 6) and clearly indicate the presence of the fluorspar mineralization. Water samples taken close to mineralized areas and a short distance downstream, contain greater than 450 ppb fluorine; lower values (36 to 250 ppb) were returned from unmineralized drainages. Water collected from near the mouth of Rock Canyon Creek, over 3 kilometres downstream from mineralization, is still significantly enriched in fluorine (Figure 13). Stream sediments and moss mats collected immediately downstream from mineralized areas contained in excess of 1100 and 1250 ppm fluorine, respectively, with a maximum of 3750 ppm in sediments. Highest values were obtained close to mineralization and significant dilution occurs downstream. Fluorite is not preferentially concentrated in moss mats over stream sediments. Higher barium, lanthanum and thorium contents were also found in the stream sediments, and more markedly, in the moss mats, near mineralized areas.

AGE AND GENESIS

A carbonatite-related origin has been suggested for the Rock Canyon Creek showing (Graf, 1985; Hora and Kwong, 1986; Pell and Hora, 1987). This interpretation appears to be consistent with preliminary geochemical data. In addition to high fluorine, REE and barium, the rocks are enriched in Fe_2O_3, MnO, MgO, strontium, yttrium, phosphorus and niobium, and have chondrite-normalized rare-earth element abundance patterns typical of carbonatites. Due to the lack of unequivocal igneous material and the gradational contacts of the mineralized zone with fresh carbonates, it is believed that the Rock Canyon Creek showing comprises metasomatically altered (fenitized) Devonian carbonate rocks, possibly related to a deep-seated alkaline intrusion.

Timing of metasomatism is poorly defined. Mineralization apparently occurred prior to the Jura-Cretaceous deformation, as no fluorite is observed west of the west boundary fault, and postdated at least part of the deposition of the basal Devonian unit. This broadly defines a time span of 280 Ma during which mineralization must have occurred. Some mineralization (Types 3 and 4, fluorite associated with solution breccias and intraformational conglomerate matrix) may have resulted from elemental remobilization and therefore may postdate the Type 1 and 2 fluorite/rare-earth deposits. It has been suggested that mineralization may have been synchronous with deposition of the basal Devonian unit (Graf, 1985). A slightly younger age is favored as most other carbonatites in the province are Devono-Mississippian to Early Mississippian (circa 350 to 380 Ma) in age (Pell, 1987).

ECONOMIC CONSIDERATIONS

High-grade fluorspar mineralization at Rock Canyon Creek has only been found in float and is therefore difficult to evaluate. Only limited surface exploration has been done; additional work is required in order to reasonably assess the fluorspar and rare-earth element potential of this area.

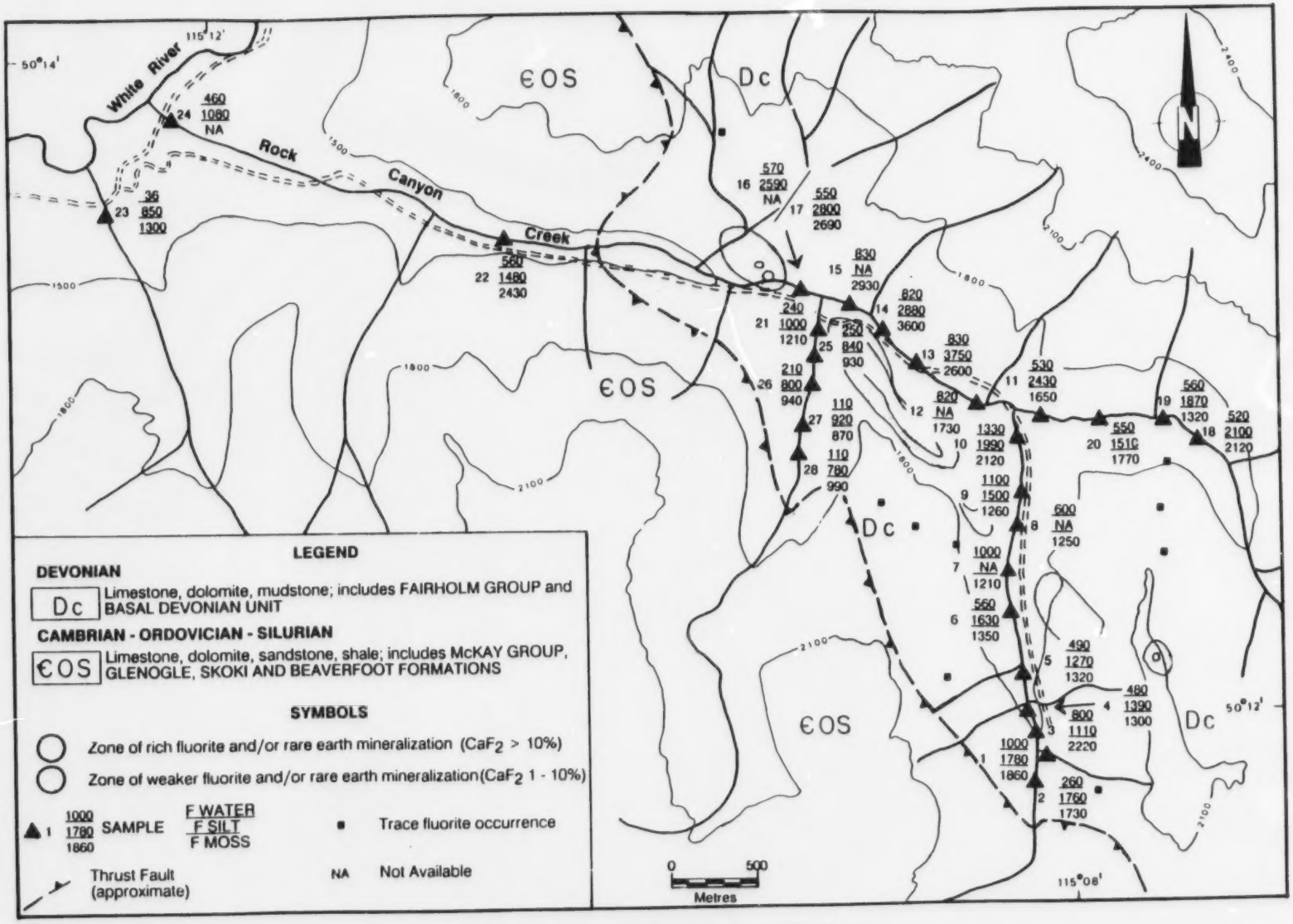

White River
Rock Canyon Creek
115°12'
50°14'
50°12'
115°08'
N
0 500
Metres
LEGEND
DEVONIAN
Dc Limestone, dolomite, mudstone; includes FAIRHOLM GROUP and BASAL DEVONIAN UNIT
CAMBRIAN - ORDOVICIAN - SILURIAN
€OS Limestone, dolomite, sandstone, shale; includes McKAY GROUP, GLENOGLE, SKOKI AND BEAVERFOOT FORMATIONS
SYMBOLS
Zone of rich fluorite and/or rare earth mineralization (CaF2 > 10%)
Zone of weaker fluorite and/or rare earth mineralization (CaF2 1 - 10%)
1 1000/1780/1860 SAMPLE F WATER / F SILT / F MOSS
Trace fluorite occurrence
Thrust Fault (approximate)
NA Not Available

Figure 13. Fluorine-in-water and silts, Rock Canyon Creek area.

TABLE 6
STREAM-SEDIMENT GEOCHEMISTRY, ROCK CANYON CREEK (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
MOSSMATS																															
82J/3 M1	10	29	46	166	0.1	55	10	607	2.72	43	5	1	19	77	1	2	2	53	5.54	0.072	30	29	2.63	301	0.01	8	0.91	0.01	0.09	2	1860
82J/3 M2	5	22	35	84	0.1	17	6	343	1.63	22	5	1	15	161	1	2	2	22	9.73	0.112	23	16	4.82	287	0.01	13	0.61	0.01	0.09	2	1730
82J/3 M3	4	13	15	191	0.1	29	5	447	1.34	18	5	0	20	133	1	2	2	32	12.91	0.086	149	16	4.71	541	0.01	13	0.64	0.01	0.13	1	2220
82J/3 M4	5	21	27	136	0.1	24	7	389	1.73	22	5	1	15	92	1	2	2	31	10.73	0.084	26	20	4.77	266	0.01	6	0.63	0.01	0.09	1	1300
82J/3 M5	8	26	40	184	0.1	32	8	426	2.06	28	5	1	16	94	1	2	2	36	8.83	0.070	27	23	4.26	326	0.01	6	0.78	0.01	0.07	2	1320
82J/3 M6	8	22	40	204	0.2	34	9	488	2.17	30	5	1	16	91	1	2	2	39	7.42	0.074	31	25	3.68	335	0.01	10	0.93	0.01	0.08	2	1350
82J/3 M7	8	19	33	172	0.1	29	7	410	1.95	25	5	1	18	96	1	2	2	34	8.73	0.065	32	22	3.98	373	0.01	16	0.80	0.01	0.08	2	1210
82J/3 M8	6	16	33	164	0.1	29	7	437	1.96	26	5	1	20	109	1	2	2	34	9.08	0.067	37	21	4.36	401	0.01	3	0.72	0.01	0.07	2	1260
82J/3 M9	6	14	35	166	0.1	26	6	463	1.87	24	5	1	21	127	1	2	2	34	9.84	0.066	48	20	4.79	498	0.01	7	0.68	0.01	0.07	1	1260
82J/3M 10	7	20	28	377	0.1	18	6	789	1.77	20	5	1	18	141	1	2	2	30	7.60	0.091	142	18	3.38	630	0.01	15	0.84	0.01	0.16	1	2120
82J/3M 11	4	18	9	326	0.1	46	5	349	1.01	17	5	0	8	80	2	2	2	32	11.91	0.103	109	12	4.36	413	0.01	9	0.45	0.01	0.16	1	1650
82J/3M 12	6	16	15	336	0.1	46	6	462	1.41	24	5	0	15	109	3	2	2	41	9.98	0.093	120	18	3.88	536	0.01	13	0.69	0.01	0.13	1	1730
82J/3M 13	6	15	16	247	0.1	40	7	453	1.26	24	5	1	19	116	1	2	2	43	12.00	0.086	137	18	4.80	497	0.01	18	0.63	0.01	0.15	1	2600
82J/3M 14	6	12	24	224	0.1	34	6	479	1.38	21	5	0	23	140	1	2	2	37	12.80	0.077	162	17	4.69	580	0.01	14	0.66	0.01	0.15	1	3600
82J/3M 15	5	13	18	223	0.1	34	6	479	1.33	18	5	0	21	133	1	2	2	36	12.55	0.086	128	16	4.50	533	0.01	17	0.66	0.01	0.14	2	2930
82J/3M 16	5	13	18	223	0.1	34	6	479	1.33	18	5	0	21	133	1	2	2	33	12.72	0.081	145	16	4.77	537	0.01	12	0.64	0.01	0.13	1	2690
82J/3M 17	4	12	15	190	0.1	33	6	460	1.31	18	7	1	21	131	1	2	2	33	12.72	0.081	145	16	4.77	537	0.01	12	0.64	0.01	0.13	1	2690
82J/3M 18	5	38	28	638	0.1	118	5	1014	1.43	21	5	1	6	85	4	2	3	32	6.99	0.148	272	16	2.28	427	0.01	18	0.77	0.01	0.23	1	2120
82J/3M 19	2	14	12	364	0.1	45	4	236	0.74	20	5	0	4	59	2	2	2	24	11.58	0.088	56	10	4.37	241	0.01	12	0.34	0.01	0.16	1	1320
82J/3M 20	4	15	10	293	0.1	44	5	348	1.02	20	5	1	8	79	2	2	2	38	12.32	0.099	105	13	5.18	334	0.01	9	0.49	0.01	0.11	1	1770
82J/3M 21	2	10	24	45	0.2	13	5	384	1.21	12	5	0	3	80	1	2	2	12	11.14	0.098	21	10	3.84	122	0.01	12	0.56	0.01	0.08	2	1210
82J/3M 22	4	12	12	147	0.1	24	5	429	1.20	17	5	1	18	106	1	2	2	28	10.81	0.089	131	14	4.78	423	0.01	9	0.56	0.01	0.10	1	2430
82J/3M 23	1	13	12	37	0.1	18	5	378	1.38	7	5	1	1	42	1	2	2	12	3.13	0.120	15	15	1.14	72	0.01	12	1.07	0.01	0.11	1	1300
82J/3M 25	2	10	21	66	0.2	14	4	357	1.03	8	5	0	2	71	1	2	2	10	9.63	0.112	16	11	2.84	106	0.01	20	0.54	0.01	0.17	2	930
82J/3M 26	2	12	22	49	0.1	13	5	376	1.09	10	5	1	2	71	1	2	2	10	9.48	0.118	14	10	3.04	103	0.01	19	0.48	0.01	0.20	3	840
82J/3M 27	1	5	13	53	0.1	13	3	372	0.87	12	5	1	1	70	1	2	2	8	10.03	0.131	11	8	2.90	59	0.01	15	0.36	0.01	0.21	2	870
82J/3M 28	1	13	15	56	0.1	16	5	469	1.21	9	5	0	1	61	1	2	2	10	7.75	0.137	14	11	2.39	83	0.01	14	0.63	0.01	0.20	1	990
STREAM SEDIMENTS																															
82J/3 S1	7	22	51	158	0.2	41	8	403	2.03	36	5	0	15	85	1	2	2	43	4.90	0.050	25	23	2.42	194	0.01	4	0.61	0.01	0.08	1	1780
82J/3 S2	5	19	31	76	0.2	16	6	314	1.21	18	5	1	17	141	1	2	2	20	9.93	0.086	21	16	4.44	191	0.01	12	0.41	0.01	0.05	1	1760
82J/3 S3	4	17	26	85	0.1	20	5	299	1.20	20	5	0	12	76	1	2	2	26	9.47	0.049	15	15	3.84	159	0.01	10	0.40	0.01	0.03	1	1110
82J/3 S4	5	17	30	121	0.2	26	6	377	1.52	23	5	1	16	100	1	3	2	32	11.37	0.060	19	21	4.66	202	0.01	11	0.47	0.01	0.05	1	1300
82J/3 S5	4	16	26	114	0.1	21	5	395	1.32	19	5	1	17	123	1	2	2	32	12.23	0.056	24	17	5.26	186	0.01	12	0.34	0.01	0.04	2	1270
82J/3 S6	4	15	26	114	0.1	21	5	395	1.32	19	5	1	17	123	1	2	2	32	12.23	0.056	24	17	5.26	186	0.01	12	0.34	0.01	0.05	1	1830
82J/3 S7	4	16	26	114	0.1	21	5	395	1.32	19	5	1	17	123	1	2	2	33	8.52	0.064	29	20	3.72	269	0.01	9	0.59	0.01	0.05	1	1830
82J/3 S8	5	14	29	146	0.2	29	7	424	1.69	28	5	0	16	91	1	2	2	32	8.82	0.063	45	18	4.14	344	0.01	9	0.53	0.01	0.04	1	1500
82J/3 S9	5	19	36	163	0.2	23	6	455	1.55	22	5	0	18	111	1	2	2	32	9.82	0.063	45	18	4.14	344	0.01	9	0.53	0.01	0.04	1	1500
82J/3S 10	6	19	24	160	0.1	23	5	526	1.53	22	5	0	23	138	1	2	2	34	10.32	0.066	62	18	4.29	421	0.01	12	0.57	0.01	0.07	1	1990
82J/3S 11	6	14	10	234	0.1	36	3	401	0.85	18	5	0	16	102	2	2	2	36	13.31	0.090	142	12	4.48	345	0.01	10	0.37	0.01	0.11	1	2430
82J/3S 13	6	10	14	180	0.1	24	4	513	0.91	17	5	0	26	136	1	3	2	33	12.04	0.071	155	13	4.12	378	0.01	18	0.40	0.01	0.11	1	3750
82J/3S 14	4	12	13	152	0.1	24	4	423	0.94	16	5	0	18	118	1	2	2	28	11.90	0.068	115	12	3.74	337	0.01	14	0.42	0.01	0.10	1	2880
82J/3S 16	3	10	16	139	0.1	23	4	415	0.89	15	5	0	14	104	1	2	2	24	11.09	0.072	98	12	3.66	299	0.01	9	0.38	0.01	0.07	1	2690
82J/3S 17	3	9	13	150	0.2	26	4	401	0.95	14	5	0	11	97	1	2	2	24	11.06	0.071	97	16	3.63	287	0.01	14	0.41	0.01	0.07	1	2800
82J/3S 18	2	13	5	230	0.3	34	4	202	0.79	21	5	0	6	48	1	2	2	29	11.10	0.095	33	11	4.51	129	0.01	13	0.33	0.01	0.09	1	2100
82J/3S 19	2	10	6	224	0.3	30	3	247	0.69	18	5	1	6	52	2	2	2	26	9.69	0.073	63	10	3.99	220	0.01	8	0.30	0.01	0.09	1	1870
82J/3S 20	3	14	10	267	0.2	38	5	296	0.84	18	5	0	5	77	2	2	2	30	13.51	0.096	87	11	4.95	237	0.01	8	0.34	0.01	0.10	1	1510
82J/3S 21	2	7	21	37	0.3	11	4	339	0.81	10	5	0	3	76	1	2	2	11	11.37	0.086	20	9	3.46	93	0.01	7	0.37	0.01	0.04	1	1000
82J/3S 22	4	13	10	137	0.3	23	5	421	1.00	15	5	1	12	86	1	2	2	27	9.96	0.087	89	11	3.77	260	0.01	8	0.48	0.01	0.08	1	1480
82J/3S 23	1	11	9	31	0.1	17	5	322	1.19	2	5	0	1	48	1	2	2	11	3.86	0.106	14	14	1.04	98	0.01	12	0.92	0.01	0.07	1	850
82J/3S 24	3	10	8	86	0.2	22	3	346	0.89	13	5	0	12	104	1	3	2	21	12.98	0.075	87	12	4.38	212	0.01	8	0.42	0.01	0.07	1	1080
82J/3S 25	6	6	26	58	0.1	10	4	366	0.84	11	5	1	3	86	1	2	2	11	12.76	0.089	21	8	3.81	93	0.01	14	0.37	0.01	0.04	1	840
82J/3S 26	1	9	15	40	0.1	10	4	373	0.96	11	5	0	2	76	1	2	2	10	11.13	0.098	16	9	3.38	88	0.01	10	0.39	0.01	0.04	1	800
82J/3S 27	1	7	19	62	0.1	12	5	485	1.10	10	5	0	2	83	1	2	2	10	9.68	0.130	15	11	2.62	78	0.01	8	0.52	0.01	0.06	1	920
82J/3S 28	1	8	11	40	0.1	13	4	418	1.01	11	5	1	1	65	1	2	2	10	9.76	0.113	14	9	2.89	87	0.01	10	0.46	0.01	0.04	1	780

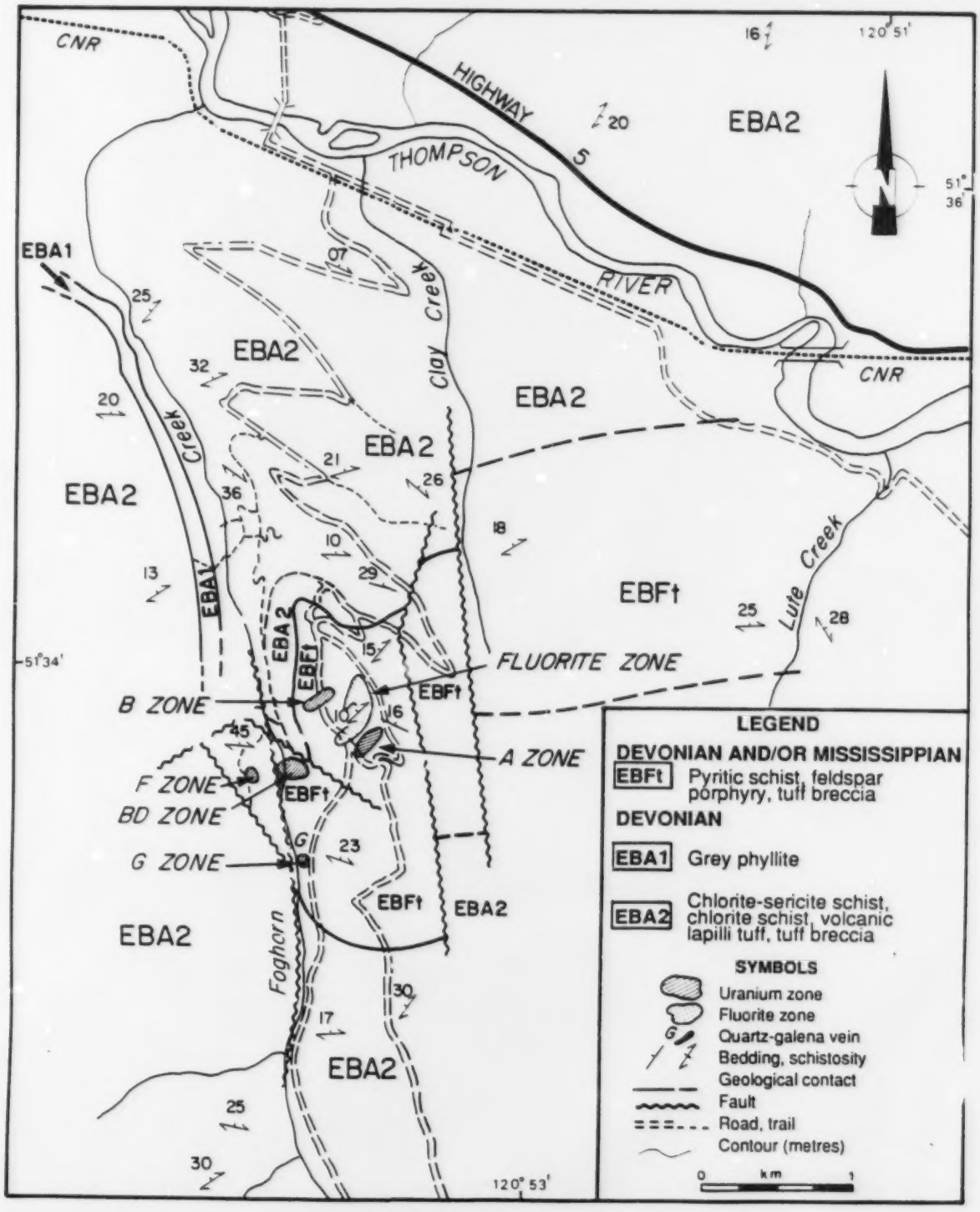


Figure 14. Generalized geology of the Rexspar property. Modified from Descarreaux, 1986; Lund, 1973; Preto, 1978 and, Pell and Fontaine, 1989.

REXSPAR

MINFILE No. 082M 007, 021, 022, 034, 043

The Rexspar deposit is located in the Omineca Belt, approximately 130 kilometres north of Kamloops and 5 kilometres south of the town of Birch Island, latitude 51°34'N, longitude 119°54'W. It is reached by the Foghorn Mountain logging road, south from Birch Island, and numerous mine roads which branch off it. The mineral deposits occur on Red Ridge, which slopes down from Granite Mountain between Foghorn and Clay creeks, at elevations of 1250 to 1370 metres (4100 to 4500 feet). The terrain is rugged and forested; however, numerous outcrops are exposed along roads, trails, trenches, creeks and cliff sections.

HISTORY

Fluorite on the Rexspar property was originally discovered and staked in 1918; lead-silver showings were found in 1926 and a bog manganese prospect was discovered north of the other showings in 1929 (Joubin and James, 1957; McCammon, 1950, 1955; Wilson, 1929). Work on the property was sporadic until the 1940s when drilling was undertaken to define the extent of fluorite mineralization. The presence of uranium was discovered in 1949 after which extensive drilling and underground work, during the early and mid-1950s, outlined three zones of uranium mineralization, the A, B, and BD or Black Diamond zones, in addition to the original fluorite zone. From 1969 to 1976, surface work and diamond drilling were done on the property, after which time it has only received minor attention. Between 1943 and 1976, approximately 17 280 metres of drilling was completed which, together with underground work, defined combined reserves of 1 114 380 tonnes grading 0.077 per cent U_3O_8 in the three uranium zones. The fluorite zone has an estimated inventory of 1 441 820 tonnes averaging 23.46 per cent CaF_2 (Descarreaux, 1986; Preto, 1978).

GEOLOGY

The rocks in the vicinity of Birch Island are part of the Eagle Bay assemblage (Figure 14), which ranges in age from Early Cambrian to Mississippian. The strata which host the Rexspar deposit are assigned to unit EBFt of the Eagle Bay and are considered to be of Devono-Mississippian age; they are correlative with the strata which host the Rea Gold volcanogenic massive sulphide-barite deposit in the Adams Plateau area to the east (Schiarizza and Preto, 1987). They comprise a shallow-dipping package of pyritic, lithic tuffs and breccias of trachytic composition, locally with some rhyolite and dacite members (Höy, 1987; Schiarizza and Preto, 1987). These rocks are light greenish to rusty weathering and have white, light grey or light green fresh surfaces and may be massive to strongly foliated; the foliated varieties are best described as sericite-albite-quartz-pyrite schists. In thin section, they are seen to comprise albite and potassium feldspar phenocrysts in a fine-grained matrix of predominantly albite and sericite. Where lithic clasts are present, they are generally of similar composition to the enclosing schists. Polylithic breccias with fragments of feldspar porphyry and fine-grained dark rocks are present in the vicinity of the A and BD mineralized zones (Preto, 1978). To the south and east of G zone (Figure 14), fine to medium-grained, equigranular, unfoliated fluorite crops out and may represent intrusive phases. Coarse breccias are also present locally.

Underlying the trachytic tuff and breccia package (Unit EBFt) is a sequence of chlorite schists, spotted sericite schists, sericite-chlorite schists, argillaceous phyllites and sandstones (Unit EBA of Schiarizza and Preto, 1987). The schists are believed to be of volcanic origin; the clearly metasedimentary rocks (*i.e.* argillaceous phyllites and sandstones) are less abundant. No mineralization occurs within this lower package.

Uranium and fluorite mineralization and associated potassic alteration are found exclusively in the upper part of the trachytic lithic tuff and breccia package (Unit EBFt). The fluorite zone measures approximately 400 by 50 metres, with an average true thickness of 24 metres (Descarreaux, 1986). It is hosted in a fine-grained, brecciated, tuffaceous trachyte which locally contains layers with abundant lithic fragments and is highly silicified and rich in pyrite (Plate 4). Potassic alteration is pervasive. Fluorite occurs as dark purple, coarse-grained fragments or fine, disseminated grains, which give the rock an overall purple colour. On the weathered surface, the coarse-grained, dark purple fluorite fragments give the rock the appearance of a lithic tuff and may be replaced rock fragments. Fluorite veins, a few centimetres to tens of centimetres wide, containing banded white to purple fluorite with or without quartz and barite, are present within this zone; molybdenite, celestite, strontianite, chalcopyrite, galena and bastnaesite have also been identified. The fluorite deposit apparently grades laterally into a dark rock composed of mica, pyrite and 5 to 10 per cent fluorite.

The main zones of uranium mineralization loosely define a semicircular ring surrounding the fluorspar zone to the south, southwest and northwest (Figure 14), and locally, overlying it. The high-grade uranium-bearing rocks are fine grained, dark grey to black and contain abundant pyrite and fluorphlogopite, up to 10 per cent fluorite and minor calcite (Preto, 1978; Descarreaux, 1986). This type of mineralization is generally conformable with layering and schistosity in the tuffs. Material from the A zone dumps consists of well-banded, pyrite-

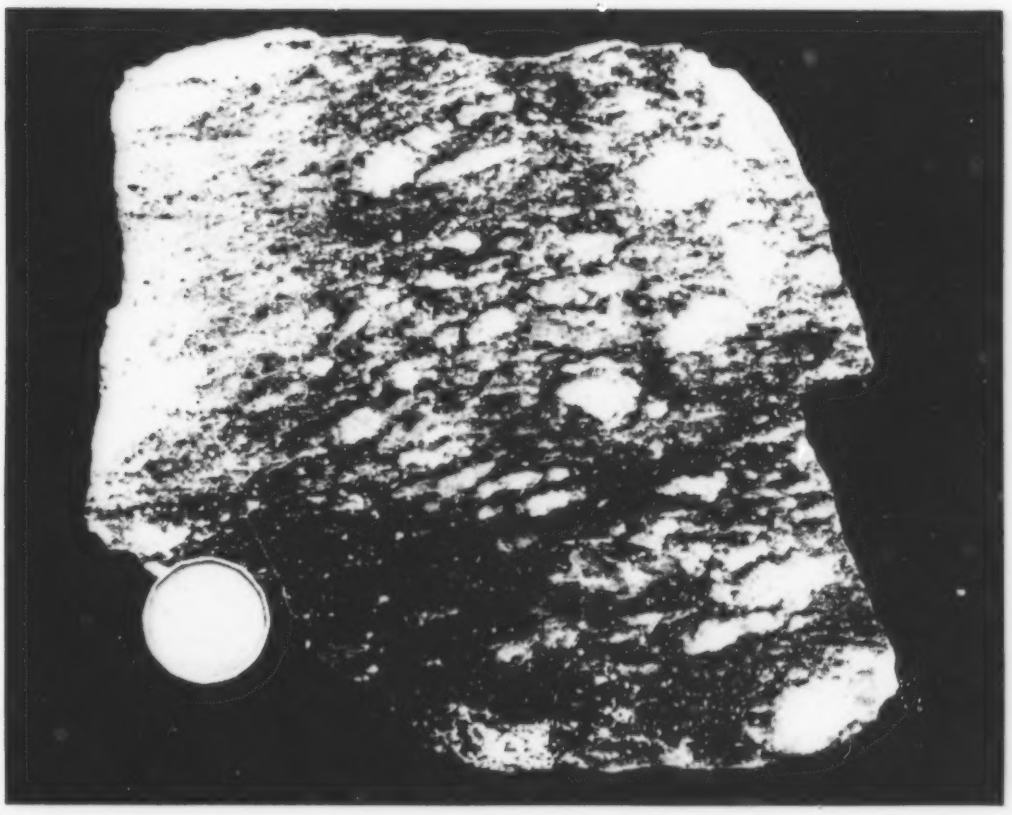


Plate 4. Lithic tuff, fluorite zone, Rexspar deposit. The tuff has been extensively replaced by fine-grained fluorite and has an overall purplish hue.

rich rocks with textures not unlike those found in volcanogenic massive sulphide deposits (Plates 5 and 6); banded pyrite-fluorite and pyrite-fluorite-mica rocks locally show contorted bedding, fragmented sulphide layers and sulphide (rip-up?) clasts (Plate 7). Locally, fluorite veins crosscut the layered mineralization.

Low-grade uranium mineralization is characterized by coarse-grained, silver-grey fluorphlogopite in replacement zones with pyrite and minor fluorite and calcite. These zones may be a few centimetres to a few metres in length, and may be either conformable or discordant, randomly oriented patches. In the G zone (Figure 14), fluorphlogopite replacements are associated with brown-weathering carbonate-filled fractures and larger carbonate pods or "sweats" in fragmental volcanic rocks. In this area, quartz-galena veins, up to a few tens of centimetres wide and pyrite-filled shears or fracture zones are also present.

A number of uranium-thorium minerals are reported in uranium zones, including uraninite, torbernite, metatorbernite, thorianite and thorite. These minerals are commonly found as inclusions in fluorphlogopite crystals or as discrete grains in the pyrite-fluorphlogopite matrix. Other accessory minerals include monazite, bastnaesite (a rare-earth fluorocarbonate), niobian ilmenorutile, apatite, celestite, galena, sphalerite, chalcopyrite, molybdenite, scheelite and barite (Preto, 1978).

Rock Geochemistry

Altered pyritic tuffs from the fluorite zone at Rexspar contain 2 to 7 per cent fluorine (5 to 13% CaF_2), less than 0.5 per cent phosphate, less than 10 ppm arsenic, are moderately enriched in barium and light rare-earths, contain anomalous molybdenum and are extremely enriched in potassium (Table 7). Veins from this zone contain 27 to 35 per cent fluorine (56 to 71% CaF_2), 4 to 9 per cent silica, approximately 400 ppm phosphate, less than 1 ppm arsenic and negligible rare-earths. These veins are extremely enriched in barium (containing 2.5 to 3.5% BaO),

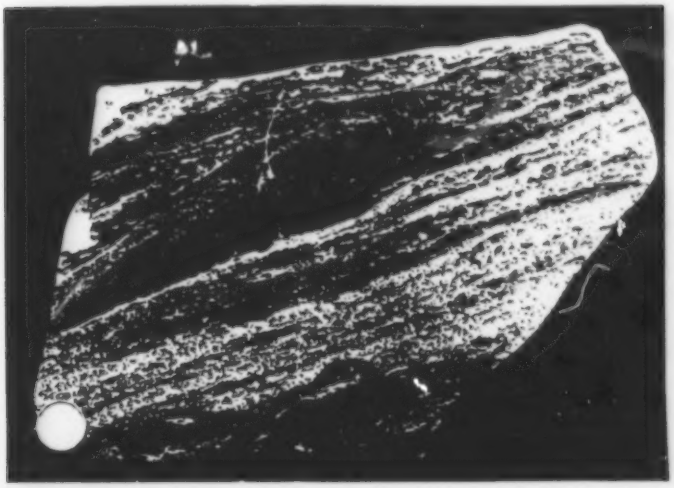


Plate 5. Layered, pyrite-rich ore, A zone. Uranium mineralization is very fine grained. Dark bands at the base of the sample are fluorite rich.

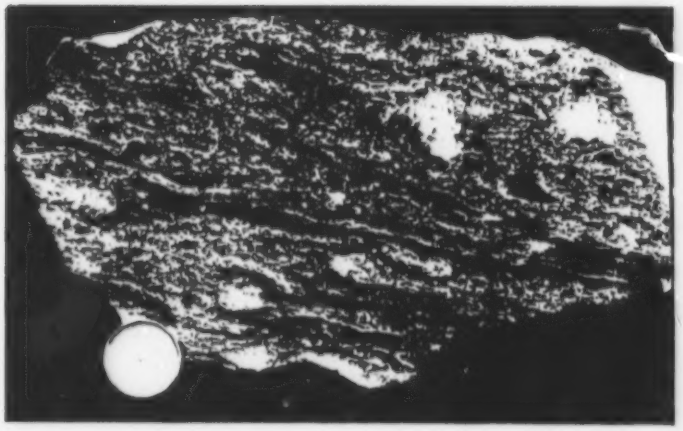


Plate 6. Fragmental A zone. Light coloured lithic clasts in a banded matrix consisting of pyrite (light, fine-grained bands) fluorite (dark, fine-grained bands) and fluorphlogopite (small, light-coloured, equant to irregularly shaped grains).

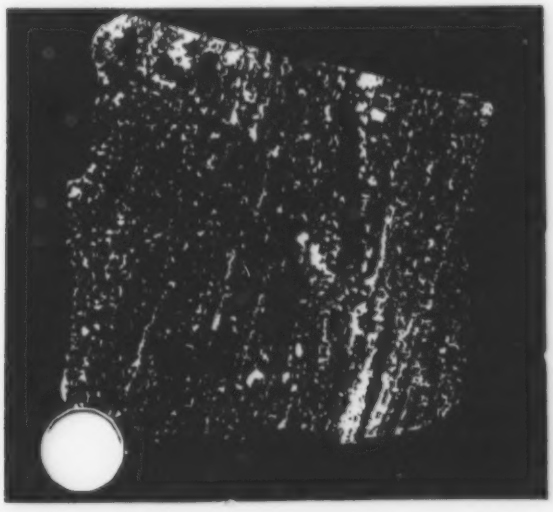


Plate 7. Sheared lithic tuff, A zone. Pyrite-rich bands present at the right edge of the sample; sheared lithic fragments (light grey) are present near centre of sample, dark coarse-grained fluorite eyes occur on the left side of the sample. Medium-grained fluorphlogopite (equant to irregular light-coloured grains).

TABLE 7
ROCK GEOCHEMISTRY, REXSPAR

SAMPLE	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F	CaF2
RX88-2B	2.42	0.02	0.56	1.07	0.11	0.65	63.77	0.30	0.14	0.18	2.12	48.00	98.63
RX88-2C	19.17	1.54	7.19	18.00	0.10	4.58	19.34	0.29	4.04	2.77	11.49	13.10	26.96
RX88-2D	25.71	0.99	8.38	14.80	0.20	10.91	9.59	0.25	5.91	8.22	9.50	5.60	11.51
RX88-2E	24.39	0.55	9.43	18.00	0.10	6.91	11.30	0.38	5.44	4.50	13.41	7.38	15.12
RX88-15A	49.80	0.42	14.90	5.84	0.07	2.63	7.51	0.54	11.00	1.87	6.93	5.38	11.06
RX88-15B	31.38	0.99	8.33	12.90	0.33	13.19	7.67	0.24	6.86	7.36	7.91	5.80	11.51
RX88-15C	44.07	0.99	12.90	7.83	0.21	8.79	3.71	0.38	11.00	3.10	3.91	4.10	8.42
RX88-15D	47.99	0.89	14.00	6.41	0.14	5.83	3.83	0.88	11.30	2.42	4.84	2.89	5.92
RX88-18	65.28	0.51	18.90	1.81	<0.01	0.25	0.83	11.10	0.35	0.18	1.25	0.34	0.70
RX88-20B	8.62	0.07	2.44	10.90	1.38	6.98	29.75	0.79	0.59	0.52	19.30	7.38	15.12
RX88-20C	50.09	0.38	15.00	3.16	0.37	3.08	8.64	2.38	8.88	1.51	7.02	0.74	1.52
RX88-20E	48.84	0.72	14.00	9.26	0.28	1.35	4.06	7.51	0.70	0.21	9.36	0.04	0.08
RX88-4C	52.07	0.34	15.60	3.90	0.02	1.09	3.78	0.78	12.30	0.41	4.35	2.66	5.47
RX88-6A	44.03	0.35	14.80	4.31	0.02	1.75	10.56	0.82	9.71	0.24	7.50	6.72	13.08
RX88-6B	8.46	0.01	0.97	1.71	0.01	0.19	47.35	0.39	0.32	0.04	3.98	34.60	71.01
RX88-6C	4.58	0.01	1.16	0.97	<0.01	0.17	48.93	0.61	0.20	0.04	2.83	27.40	56.38

SAMPLE	Au	Ag	As	Sb	Mo	Cu	Pb	Zn	Co	Ni	Cr	Sn	W	Cs	Sc	Zr
RX88-2B	6	<5	<1	<0.2	6	234	25	18	11	2	<50	24	45	<1.0	0.9	<5
RX88-2C	130	<5	20	2.3	183	164	35	203	32	2	2	34	208	7.0	8.7	210
RX88-2D	180	<5	17	1.1	13	389	39	520	23	2	2	34	60	18.0	5.7	100
RX88-2E	270	<5	72	137.0	220	295	238	420	31	2	<100	29	150	7.1	3.7	X
RX88-15A	<15	10	12	1.0	63	68	600	129	22	2	170	34	<30	6.5	21.0	326
RX88-15B	90	<5	37	2.6	94	49	135	780	33	4	87	38	69	21.0	18.0	85
RX88-15C	33	14	10	2.1	57	29	55	420	14	2	170	31	74	15.0	17.0	230
RX88-15D	26	12	12	1.3	76	39	387	320	18	2	190	32	89	9.2	17.0	320
RX88-18	<5	<5	10	1.1	60	11	159	10	16	7	2	32	140	<1.0	2.1	490
RX88-20B	29	19	38	2.3	270	63	191	320	11	3	200	26	38	<1.0	8.0	65
RX88-20C	<5	<5	7	0.8	31	45	184	108	11	3	80	21	77	2.9	4.0	310
RX88-20E	1760	270	39	4.3	1000	1300	2.00%	0.25%	25	11	89	32	110	<1.0	3.8	110
RX88-4C	34	<5	8	1.1	260	38	311	96	11	3	82	23	80	3.7	5.0	X
RX88-6A	35	14	3	1.1	550	17	375	89	8	4	130	28	84	3.4	5.3	X
RX88-6B	24	<5	<1	<0.2	6	1700	77	40	4	2	<50	<32	38	<1.0	<0.5	X
RX88-6C	22	<5	<1	<0.2	6	730	28	6	2	2	<150	8	17	<1.0	<0.5	X

SAMPLE	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
RX88-2B	1300	66	110	3.9	<2	1	<5	<.5	120	39.0	28	<10	3800	41	<1.0
RX88-2C	1300	2100	2540	118.0	24	12	<10	<.5	X	493.0	435	350	1200	40	6.3
RX88-2D	740	1600	3070	186.0	31	17	<9	<.5	X	429.0	355	880	2000	555	10.0
RX88-2E	2100	2720	3830	131.0	23	9	<15	<1.2	X	1160.0	1940	380	1400	X	8.8
RX88-15A	2500	1910	2990	111.0	<12	7	<11	<.5	135	266.0	26	500	700	10	<2.1
RX88-15B	480	3550	6780	312.0	45	23	<15	2.8	320	980.0	22	740	970	20	1.7
RX88-15C	1800	740	1440	88.4	14	5	8	<.5	77	374.0	18	710	720	72	2.8
RX88-15D	1800	1370	2280	97.5	17	8	10	1.0	100	242.0	12	640	820	85	3.3
RX88-18	780	480	890	28.0	6	2	<5	<.5	37	54.9	7	<38	430	27	3.8
RX88-20B	1100	3380	4070	112.0	27	7	13	<.5	115	74.3	48	29	1300	<5	<1.0
RX88-20C	6800	320	530	20.0	<2	2	<5	<.5	38	29.0	11	250	1000	55	2.3
RX88-20E	7300	767	1080	32.0	6	3	<5	<.5	X	47.0	12	<38	700	10	2.2
RX88-4C	3600	908	1270	40.0	<6	3	<5	<.5	<5	37.0	30	380	>10000	10	2.9
RX88-6A	3500	2880	3500	90.6	<16	6	12	1.3	<5	117.0	41	370	>10000	<5	<2.7
RX88-6B	27400	32	44	1.3	<2	<1	<5	<.5	<5	2.4	<0.5	15	>10000	10	<1.0
RX88-6C	30800	28	<10	1.2	<2	<1	<5	<.5	<5	1.9	<0.5	<10	>10000	10	<1.0

Major element data in per cent, trace elements in parts per million, except Au, which is in parts per billion. X= Not detected. Sample descriptions as follows: RX88-2B pure, coarse grained purple fluorite, A Zone; RX88-2C banded, pyrite and fluorite-rich volcanogenic sulphide horizon, A Zone; RX88-2D mica and pyrite-rich replacement mineralization in altered volcanics, A Zone; RX88-2E mica-pyrite-fluorite replacement mineralization in altered volcanic rocks, A Zone; RX88-15A metavolcanic with fluorite, B Zone; RX88-15B altered volcanic with mica, B Zone; RX88-15C coarse-grained mica-fluorite replacement mineralization, B Zone; RX88-15D altered volcanic rock with coarse mica, B Zone; RX88-18 felsic volcanic rock, outside mineralized areas; RX88-20B carbonate-fluorite-pyrite segregation, G Zone; RX88-20C felsic volcanic with disseminated fluorite and pyrite, some galena in veins, G Zone; RX88-20E felsic volcanic with pyrite and galena, disseminated and in stringer veinlets, G Zone; RX88-4C pyritic tuff, Fluorite zone; RX88-6A disseminated fluorite in quartz-pyrite-sericite schist (altered felsic metavolcanic), Fluorite zone; RX88-6B fluorite vein, fluorite Zone; RX88-6C pale purple and white, banded fluorite-barite vein, Fluorite zone.

and are locally anomalous in copper. Mineralized rocks (both veins and altered tuffs) in the fluorite zone contain much greater amounts of strontium and less combined uranium and thorium than rocks from the A or B mineralized zones.

Samples collected from the dumps on the A zone, which consist of layered sulphides with fluorspar and uranium mineralization, contain 5 to 13% fluorine (11 to 27% CaF_2), high iron (15 to 18% Fe_2O_3), high phosphate (3 to 8%), high uranium and thorium, moderate potassium (4 to 6%), anomalous light rare-earths, and low silica (18 to 26%). One selected fluorite sample from this zone contained 48 per cent fluorine, or approximately 98 per cent CaF_2, slightly over 2 per cent silica, low rare-earths, uranium, thorium and arsenic and relatively high phosphorus (0.18% P_2O_5). Material from the B zone consists of altered volcanics containing moderate amounts of fluorite (approximately 5 to 12% CaF_2 or 3 to 6% fluorine), high potassium (6 to 11%), anomalous thorium and light rare-earths, low strontium, and minimal amounts of uranium. The G zone contains highly variable amounts of fluorine (0.04 to 7.36%), low uranium and thorium and locally anomalous base metals, molybdenum and gold (Table 7).

Stream-water and Silt Geochemistry

Detailed stream-water and sediment samples were collected in the vicinity of the Rexspar showing for geochemical analyses (Figure 15, Tables 8, 9). Waters collected downstream from showings contained in excess of 300 ppb fluorine. Statistical analyses of regional geochemical (RGS) data for NTS 82M (Figure 8) indicate that the threshold separating background from anomalous values for areas underlain by schists, which includes the Eagle Bay assemblage, is 150 ppb. Waters collected downstream from mineralized areas are clearly anomalous with respect to fluorine. The presence of mineralization is also evident from silt samples; silts collected downstream of mineralization contain greater than 1250 ppm fluorine, while those collected upstream, and in unmineralized drainages generally contain less than 1000 ppm fluorine. Lanthanum, molybdenum, lead and, to a lesser extent, thorium and silver are also concentrated in silts downstream of mineralized outcrops.

Age and Genesis

Mineralization at Rexspar is believed to be syngenetic with the hostrocks, and therefore Devono-Mississippian in age (Preto, 1978). Preto suggests that the pyrite-mica zones and the uranium mineralization were formed by deuteric volatile-rich fluids during a late stage in the formation of the trachyte unit. The presence of related intrusive rocks, rhyolites and coarse breccias may indicate proximity to a volcanic vent. The distinct banded textures and sulphide clasts in the A zone support a volcanogenic origin. Discordant mineralization could have been produced by later (deuteric) fluids cutting slightly older rocks. Early workers suggested the alternative hypothesis that mineralization is related to nearby Cretaceous granitoids.

Radiometric dating has not provided conclusive results. Potassium-argon analyses of mica from a coarse pyrite-mica rock indicate a 236±8 Ma age; gas extraction during the analysis was poor, and this is considered to be a minimum age for mineralization (Morton *et al.*, 1978). Although the data do not indicate a Middle Paleozoic age, they rule out any relationship with the Cretaceous granitic rocks. Lead-lead ages of galenas from the Rexspar deposit fall between Middle Jurassic and Tertiary (Goutier, 1986). These are considered problematic due to the highly radiogenic lead component generated by the nearby mineralization.

Studies of fluid inclusions in fluorite from the uranium zones (Morton *et al.*, 1978) indicate that two types of primary inclusions are present, one containing aqueous liquid plus vapor and a second containing aqueous liquid plus liquid carbon dioxide plus vapor. The coexistence of these two types of fluid inclusions may indicate that they were trapped during a boiling event, when magmatic carbon dioxide was exsolving from the fluid phase. It is considered likely that the uranium was transported as carbonate complexes in a weakly saline system charged with carbon dioxide of volcanic origin. As the solutions neared surface, the sudden pressure drop and concomitant effervescence and release of carbon dioxide would result in the precipitation of uranium minerals at or near the surface (Morton *et al.*, 1978), supporting the volcanogenic hypothesis.

Only one type of fluid inclusion is present in fluorite from the fluorite zone; inclusions containing aqueous liquid plus vapour. There is no evidence for the presence of a carbon dioxide rich phase (Morton *et al.*, 1978). The lack of carbon dioxide in the system probably precluded mobilization or transport of uranium and therefore explains the absence of uranium in the fluorite zone. This apparent difference in the composition of the fluids also suggests that the fluorite zone may have formed at a slightly different time, possibly after the uranium was mobilized, removed from the system and deposited elsewhere, or after an incursion of meteoric water into the system (Morton *et al.*, 1978).

Economic Considerations

A significant and potentially economic grade and tonnage of fluorspar has been outlined in the Rexspar fluorite zone. Grab samples, analyzed at between 5 and 71 per cent CaF_2, with low arsenic and low phosphorus,

TABLE 8
STREAM-WATER CHEMISTRY, REXSPAR

SAMPLE NO.	U ppb	F ppb	pH
82M/12-1	2.2	350	7.9
82M/12-2	0.35	90	8.0
82M/12-3	0.02	32	7.7
82M/12-4	0.38	200	8.3
82M/12-5	0.14	22	8.2
82M/12-6	0.41	30	8.3
82M/12-7	0.02	600	7.1
82M/12-8	1.8	400	8.0
82M/12-9	0.37	220	8.0
82M/12-10	0.66	200	8.0
82M/12-11	0.33	28	8.0
82M/12-12	0.34	36	8.2
82M/12-13	2.3	300	7.8
82M/12-14	0.44	2000	6.9

TABLE 9
STREAM-SEDIMENT GEOCHEMISTRY, REXSPAR (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb
82M/12 S1	8	82	118	186	0.6	26	18	711	4.49	28	5	0	16	229	1	2
82M/12 S2	4	103	76	267	0.3	22	23	856	5.28	29	5	0	9	87	1	2
82M/12 S3	1	171	47	228	0.3	28	27	865	5.87	55	5	0	4	20	1	2
82M/12 S4	1	52	41	111	0.1	30	15	704	3.59	12	5	0	3	28	1	2
82M/12 S5	1	47	31	90	0.1	57	21	864	4.16	17	5	0	4	34	1	2
82M/12 S6	1	35	28	78	0.1	40	15	486	4.42	21	5	0	3	35	1	2
82M/12 S7	10	137	101	243	0.7	34	12	520	3.17	9	5	1	4	208	1	2
82M/12 S8	9	108	126	197	0.6	22	19	859	4.68	38	5	1	13	179	2	3
82M/12 S9	1	131	28	120	0.3	16	20	784	4.50	53	5	0	2	41	1	2
82M/12 S10	2	111	58	139	0.4	18	19	781	4.36	43	5	0	4	64	1	2
82M/12 S11	1	35	20	94	0.2	6	14	6345	1.90	2	5	0	1	358	1	2
82M/12 S12	1	31	47	83	0.1	21	14	631	2.51	10	5	1	5	93	1	2
82M/12 S13	10	78	135	177	0.5	20	18	748	4.32	33	5	0	14	203	1	2
82M/12 S14	7	78	107	400	0.3	32	14	742	3.57	21	5	0	8	289	2	2

SAMPLE NO.	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
82M/12 S1	18	28	0.96	0.143	111	15	0.83	248	0.03	2	1.16	0.01	0.14	1	2370
82M/12 S2	2	28	0.65	0.084	32	17	0.95	105	0.03	2	1.23	0.01	0.08	1	1320
82M/12 S3	2	26	0.45	0.082	17	15	1.12	55	0.01	3	1.55	0.01	0.04	1	780
82M/12 S4	2	25	0.50	0.065	25	18	0.94	44	0.02	2	1.48	0.01	0.05	1	820
82M/12 S5	2	38	0.83	0.108	25	50	0.78	37	0.03	5	1.03	0.01	0.04	2	550
82M/12 S6	2	38	0.72	0.077	12	34	0.57	34	0.02	3	0.72	0.01	0.04	1	490
82M/12 S7	2	19	0.38	0.076	61	15	0.41	147	0.02	5	1.40	0.01	0.13	1	1520
82M/12 S8	2	25	0.82	0.129	83	15	0.81	148	0.02	2	1.04	0.01	0.11	1	2340
82M/12 S9	2	30	0.64	0.078	11	13	0.95	84	0.02	2	1.28	0.01	0.08	1	680
82M/12 S10	2	27	0.88	0.105	23	14	0.90	142	0.02	2	1.17	0.01	0.09	1	870
82M/12 S11	2	15	1.38	0.123	34	13	0.41	626	0.02	2	0.84	0.01	0.05	1	880
82M/12 S12	2	21	0.57	0.143	44	18	0.81	166	0.02	2	0.77	0.01	0.06	1	1060
82M/12 S13	2	23	0.81	0.140	102	13	0.71	148	0.02	2	0.85	0.01	0.1	1	2810
82M/12 S14	2	20	0.44	0.075	67	12	0.41	129	0.02	2	1.03	0.01	0.1	1	1270

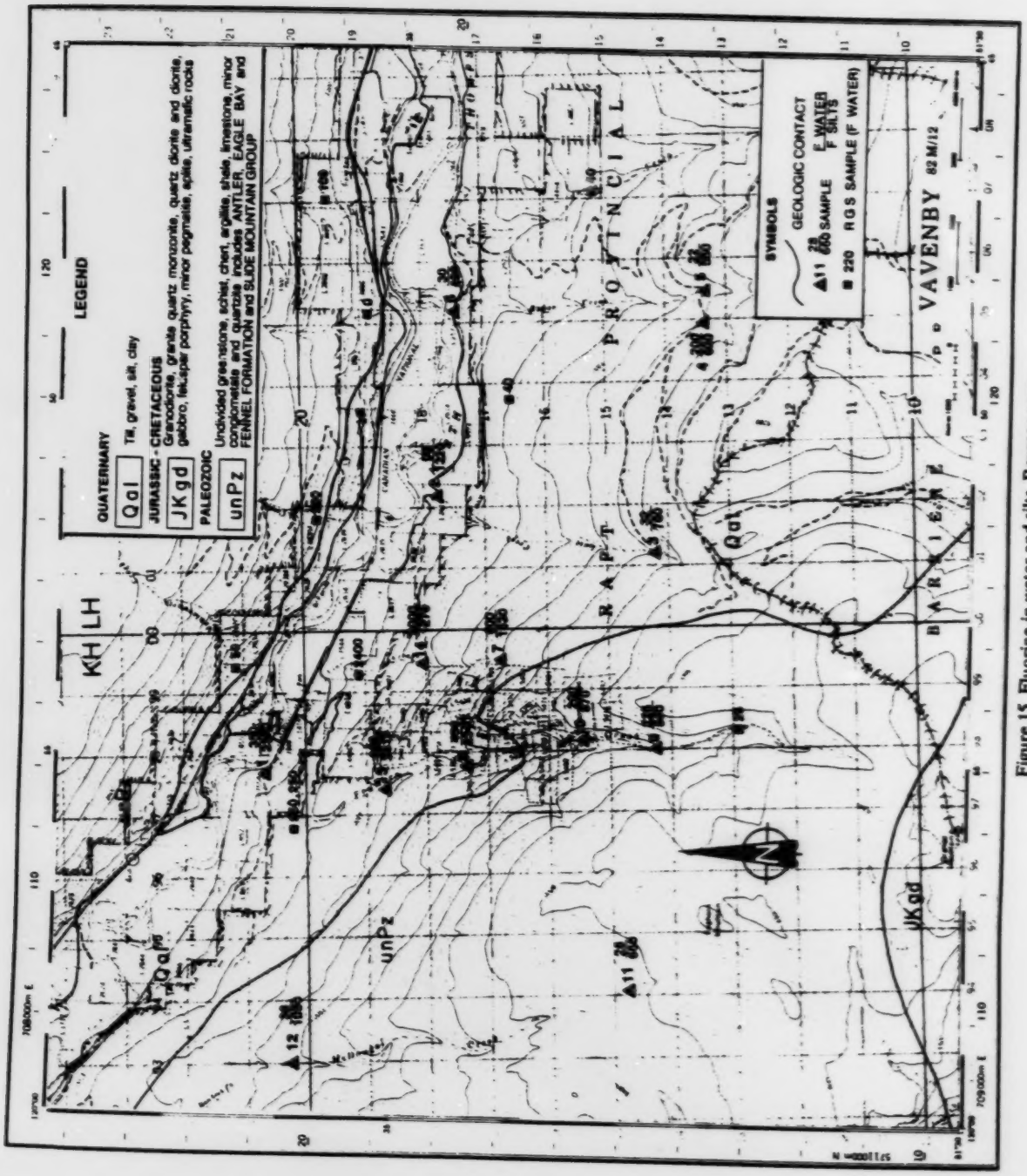


Figure 15. Fluorine-in-water and silts, Raspar area.

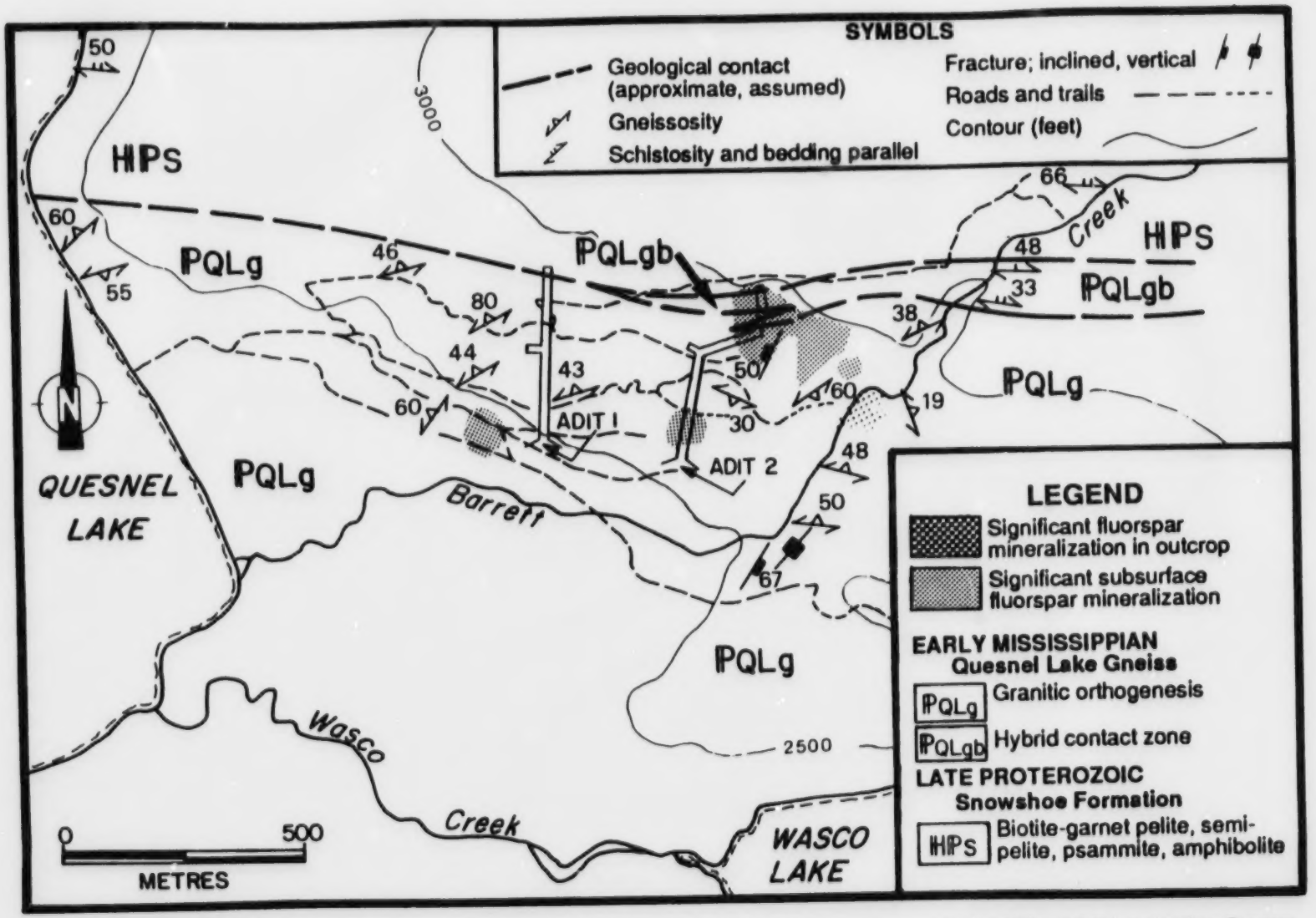


Figure 16. Geological map of the Eaglet Prospect. Compiled from Pell and Fontaine, 1989; P. Read, personal communication, 1989 and drill-hole data from Company and Assessment Reports.

have been collected from this zone which is estimated to contain approximately 1.4 million tonnes grading slightly in excess of 23 per cent CaF_2. Beneficiation tests performed by Canmet have indicated that, through grinding and flotation, concentrates containing 85 to 95 per cent CaF_2 can be produced from typical ore samples (Collings and Andrews, 1988). High-grade samples returned concentrates containing as much as 97.1 per cent CaF_2. Celestite concentrates containing up to 81 per cent $SrSO_4$ were also obtained (Collings and Andrews, 1988). The logistics of mining in this area are favorable in that transportation and a local work force are readily available; however, the proximity to a subeconomic uranium prospect has resulted in strong political opposition to development. As well, the probability of producing an acid grade concentrate using traditional benefication techniques is low.

EAGLET

MINFILE No. 093A 046

The Eaglet fluorspar property is located in the Omineca Belt, on the east side of Quesnel lake approximately 3.5 kilometres northeast of the junction of the North Arm and the main Lake, at latitude 52°33'N and longitude 121°00'W. Access is from Williams Lake by road, through the town of Horsefly, to the south shore of Quesnel Lake, a distance of 125 kilometres. From the south shore, a boat may be taken 8 kilometres across the lake to the mouth of Barrett Creek which is on the property. Numerous mine roads transect the property and lead to the lakeshore. Outcrops in the area are sparse; however, some fluorite mineralization is exposed on the slopes between Barrett Creek and Quesnel Lake, and in the Barrett Creek canyon at elevations of 760 to 915 metres.

HISTORY

The fluorite showing on Barrett Creek was discovered by a prospector in 1946. Preliminary work was done on the property in the mid-1960s and from 1973 to 1983 extensive exploration involving surface work, drilling, driving of two adits and underground drilling was carried out (Ball and Boggaram, 1984; McCammon, 1966).

GEOLOGY

Fluorspar mineralization is associated with aplitic granitic rocks and leucocratic granitic gneisses which crop out on the east shore of Quesnel Lake. These rocks occur within the Quesnel Lake gneiss, a hornblende-pyroxene granodioritic orthogneisses of Late Devonian to Early Mississippian age (Mortensen *et al.*, 1987) near its contact with Late Proterozoic Snowshoe Group metasedimentary rocks (Figure 16).

The dominant lithology in the vicinity of the fluorite showings is a fine to medium-grained granitic gneiss that is grey to rusty weathering and has a white to pink fresh surface. It is composed predominantly of feldspars and quartz with 5 to 10 per cent biotite and displays a weakly developed gneissosity. Biotite-rich bands, pegmatitic segregations and aplitic dikes are all present locally within the gneiss. At one locality, pink-weathering carbonate "sweats" were observed parallel to gneissosity. Fluorite is ubiquitous, occurring as grains disseminated throughout the gneiss in amounts from a trace to a few per cent, and traces of molybdenite are also present locally. The protolith of the gneiss is unknown; it may, in part, be sedimentary in origin (P.B. Read, personal communication, 1989) or, in part, correlative with the type Quesnel Lake gneiss.

Near Barrett Creek, the gneiss is bordered to the north by biotite-garnet pelites, semipelites, garnet amphibolites and minor marbles of the Snowshoe Group. The contact of the gneiss and the metasediments strikes easterly and has a shallow northerly dip, with the metasediments structurally overlying the gneiss. Relationships exposed in outcrops in the Barrett Creek canyon clearly show that this is an intrusive contact; apophyses of the granitic gneiss crosscut the metasediments and large xenoliths of metasediment are included within the gneiss near its margins.

In addition to disseminated grains, fluorite occurs as thin films on fractures in the gneiss, as veins up to 10 centimetres thick and as pods and irregular replacement bodies within the gneiss. Locally, fluorspar is present in greisen-like zones with abundant secondary mica and pyrite. The majority of fluorite exposed in outcrop varies from pale purple to black in colour. Coarse-grained calcite-fluorite-galena veins, 15 to 20 centimetres wide, are exposed in Barrett Creek, near the contact of the gneiss and metasediments. Sphalerite and tetrahedrite are reportedly associated with these veins (Ball and Boggaram, 1984).

Economic concentrations of fluorspar are not evident at surface; however, drill holes and adits have delineated significant mineralization. A number of drill holes have intersections of between 9 and 21 metres of 11.5 to 19.5 per cent CaF_2 (Ball and Boggaram, 1984). Adit 2 (Figure 16) also intersected significant mineralized zones and reserves in the vicinity of this adit are estimated at 1.8 million tonnes of 15 per cent CaF_2 (Ball and Boggaram, 1984). The fluorspar from the adit, which is intimately associated with the late aplitic dikes (P.B. Read, personal communication, 1989), is medium to fine grained and predominantly white to cream in colour; some pale green, pale bluish grey and light to dark purple fluorite is also present. Texturally the fluorspar varies from massive to

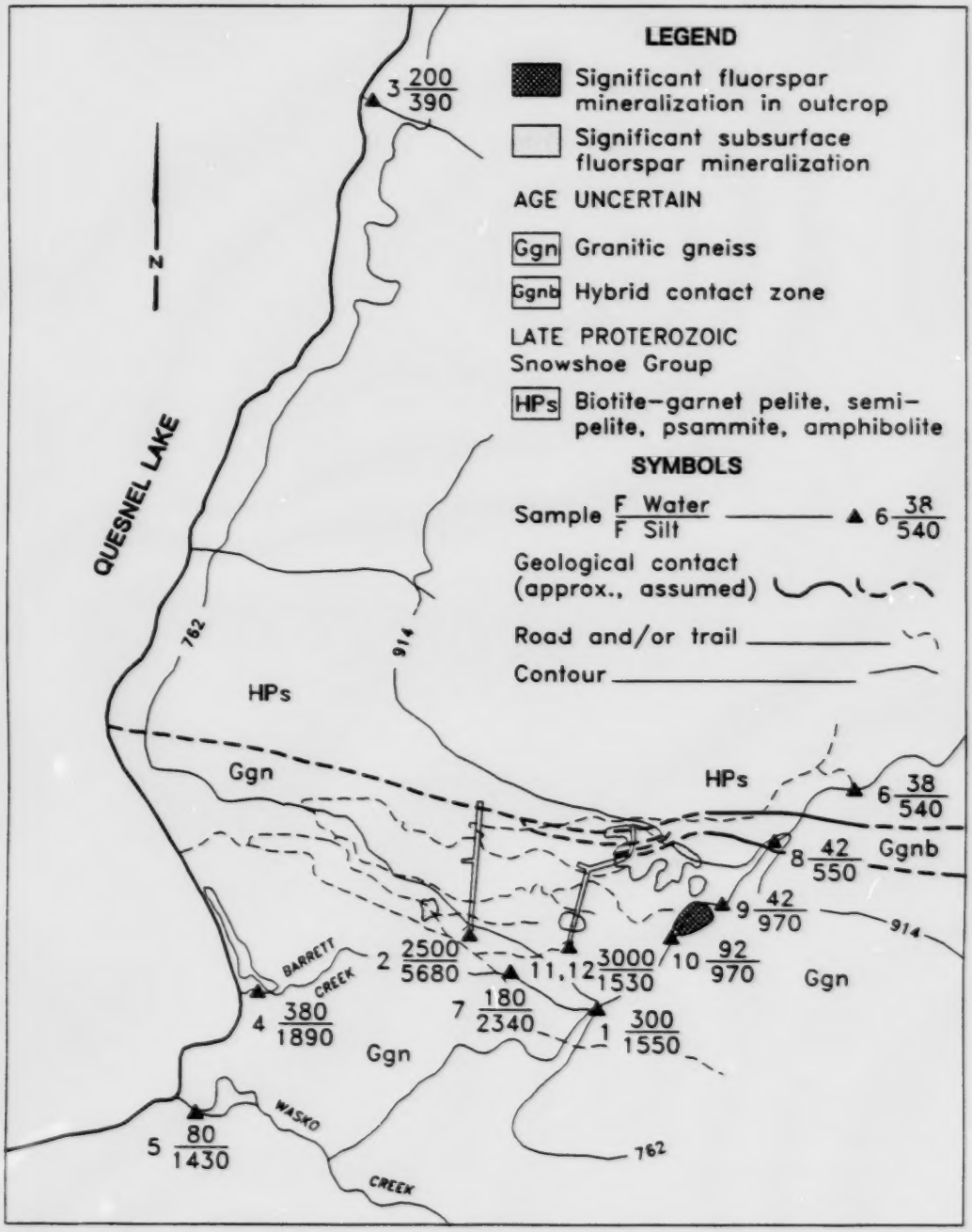


Figure 17. Fluorine-in-water and silts, Eaglet area.

TABLE 10
ROCK GEOCHEMISTRY, EAGLET MINE

SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F	CaF2
EG88-2	43.43	0.08	12.34	2.86	0.34	0.33	15.88	3.83	5.01	0.08	9.04	1.47	3.02
EG88-7	46.78	0.11	8.17	8.17	0.24	1.78	17.68	2.83	3.30	0.07	5.21	7.36	15.12
EG88-14A	7.78	0.03	2.58	0.79	0.03	0.02	58.22	0.30	0.54	0.03	4.12	42.24	86.78
EG88-14B	52.63	0.03	11.87	0.66	0.01	0.18	18.68	0.20	0.36	0.18	8.16	11.87	24.60
EG88-14D	26.80	0.02	8.17	0.60	0.03	0.17	36.78	0.27	2.68	0.07	8.92	24.32	49.92
EG88-14G	66.02	0.16	17.78	0.81	0.02	0.19	4.70	0.25	2.56	0.06	7.67	2.23	4.58
EG88-28B	8.56	0.04	3.07	1.32	0.64	0.31	45.63	0.43	1.50	0.07	30.84	8.64	17.56
EG88-29	42.24	0.04	4.74	4.06	0.10	0.29	26.09	0.31	2.46	0.28	5.48	16.64	34.19
EG88-14H	76.11	0.16	12.56	2.48	0.01	0.27	1.48	0.30	4.09	0.07	3.84	0.59	1.21
EG88-15	66.10	0.04	16.70	1.50	0.03	0.20	1.96	3.50	8.94	0.06	1.07	0.96	1.97
EG88-20B	67.87	0.06	22.78	2.81	0.04	0.26	0.89	2.90	9.62	0.06	1.79	0.21	0.43
EG88-26A	30.18	0.02	4.16	0.37	1.07	0.27	30.86	0.17	2.30	0.04	20.22	4.93	10.13
EG88-28	68.56	0.06	16.37	2.03	0.08	0.30	6.17	2.24	8.66	0.10	4.30	2.11	4.34

SAMPLE NO.	Au	Ag	As	Sb	Mo	Cu	Pb	Zn	Co	Ni	Cr	Sn	W	Ce	Sc	Zr
EG88-2	<5	<5	1	0.4	22	12	60	28	6	2	<50	23	25	<1.0	0.7	X
EG88-7	<5	10	<1	<0.2	6	5	13	220	18	2	<50	28	140	1.6	12	<5
EG88-14A	<5	<5	<1	<0.2	6	2	13	16	5	2	<50	24	29	1.1	1.2	<5
EG88-14B	<5	<5	<1	0.7	6	7	16	19	5	2	<50	17	42	2	0.6	<5
EG88-14D	<5	<5	<1	<0.2	9	13	13	6	4	2	<50	22	16	<1.0	<0.5	<5
EG88-14G	<5	<5	<1	0.5	3600	4	13	19	11	3	<50	26	110	1.6	2.5	190
EG88-28B	<5	<5	<1	1	6	6	32	27	6	2	<50	26	30	<1.0	0.5	<5
EG88-29	<10	55	<7	0.5	6	6	3000	268	21	2	77	47	2820	1.6	1.1	<5
EG88-14H	<5	5	<1	0.6	13	3	13	32	18	2	<50	22	267	1.1	2.7	71
EG88-15	<5	<5	<1	<0.2	6	7	28	19	26	2	<50	26	271	1.3	0.8	166
EG88-20B	11	<5	<1	<0.2	6	4	28	70	11	2	<50	24	83	1.8	<0.5	230
EG88-26A	<5	33	<1	0.2	6	9	31300	10300	9	2	<50	30	653	<1.0	2	<5
EG88-28		<5	<5	<1	0.6	6	7	99	81	11	2	<5024	120	2.8	0.9	585

SAMPLE NO.	Be	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
EG88-2	680	110	170	4.8	<2	<1	<5	<.5	X	23	48	170	3600	45	4
EG88-7	1100	80	130	5	<2	<1	<5	<.5	<5	66	3.7	190	3600	65	<1.0
EG88-14A	1200	360	680	20	<2	1	<5	<.5	<5	166	20	22	7200	20	<1.0
EG88-14B	1100	29	46	2.3	<2	<1	<5	<.5	<5	3.4	4.8	18	8200	20	<1.0
EG88-14D	1000	18	46	2.4	<2	<1	<5	<.5	<5	3.8	1.6	78	6600	10	<1.0
EG88-14G	580	26	32	3	<2	2	<5	<.5	66	14	4.1	81	1200	10	2.3
EG88-28B	360	380	680	14	<4	1	<5	<.5	<5	26	16	66	7000	10	<1.0
EG88-29	920	6280	7760	98.6	14	4	<14	<.5	<5	1030	37	86	1600	10	<1.0
EG88-14H	640	40	84	4.4	<2	<1	<5	<.5	<5	28	6.2	140	1200	50	1.7
EG88-15	480	13	36	1.2	<2	<1	<5	<.5	<5	72.7	8.7	260	1100	37	1.6
EG88-20B	1000	86	140	2.2	<2	<1	<5	<.5	<5	16	6.2	330	1700	36	2.1
EG88-26A	630	110	190	12	2	2	<5	<.5	X	18	7.7	76	2100	X	<1.0
EG88-28	1200	200	280	3.4	<2	<1	<5	<.5	<5	117	101	240	2100	110	6.6

Major element data in per cent, trace element data in parts per million, except Au, which is in parts per billion. X = Not detected. Sample descriptions as follows: EG88-2 massive, pink granite with fluorite; EG88-7 biotite-pyrite-fluorite rich gneiss; EG88-14A pure, dark purple fluorite; EG88-14B green to white fluorite with quartz and celestite; EG88-14D green and pale purple fluorite (with quartz?); EG88-14G fluorite-molybdenite vein or replacement; EG88-28B pink marble segregation in gneiss, with dark purple fluorite; EG88-29 dark purple fluorite replacement in gneiss; EG88-14H weakly altered gneiss; EG88-15 pink, foliated granitic gneiss with trace of fluorite and pyrite; EG88-20B pegmatitic segregation within gneiss; EG88-26A calcite-purple fluorite-galena vein; EG88-28 pink granitic gneiss with disseminated fluorite.

TABLE 11
STREAM-WATER CHEMISTRY, EAGLET

SAMPLE NO.	U ppb	F ppb	pH
93A/10-1	0.11	300	6.9
93A/10-2	150.0	2500	7.6
93A/10-3	0.17	200	7.4
93A/10-4	0.02	380	6.7
93A/10-5	0.09	80	6.9
93A/10-6	0.02	38	6.9
93A/10-7	0.13	180	6.9
93A/10-8	0.09	42	6.7
93A/10-9	0.02	42	7.1
93A/10-10	0.1	92	6.9
93A/10-11	120.0	3000	7.7
93A/10-12	120.0	2600	8.1

TABLE 12
STREAM-SEDIMENT GEOCHEMISTRY, EAGLET (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd
93A/10 S1	1	18	26	86	0.1	27	10	280	1.98	2	5	0	7	37	1
93A/10 S2	1	14	148	287	0.1	18	8	840	1.7	4	5	1	24	1081	2
93A/10 S3	1	18	18	70	0.1	24	11	782	2.65	2	5	0	4	51	1
93A/10 S4	1	14	38	83	0.1	32	10	210	2.01	2	5	0	14	42	1
93A/10 S5	1	10	26	51	0.2	26	8	129	1.48	2	5	1	10	26	1
93A/10 S6	1	19	14	88	0.1	33	11	228	2.18	4	5	0	5	23	1
93A/10 S7	1	23	41	70	0.1	35	11	314	2.25	2	5	1	10	41	1
93A/10 S8	1	15	36	55	0.1	34	13	243	2.28	2	5	1	8	22	1
93A/10 S9	1	20	37	80	0.1	33	12	278	2.14	2	5	1	11	27	1
93A/10 S10	1	17	20	65	0.1	28	9	218	1.78	4	5	0	8	28	1
93A/10 S11	1	24	100	140	0.2	37	12	574	2.61	2	5	0	20	508	1
93A/10 S12	1	22	92	143	0.2	48	13	606	2.71	8	5	0	25	378	1

SAMPLE NO.	Sb	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
93A/10 S1	2	2	18	0.34	0.055	38	18	0.57	80	0.05	2	0.8	0.01	0.12	1	1550
93A/10 S2	2	2	17	1.48	0.039	86	18	0.37	97	0.04	2	0.88	0.04	0.18	5	5880
93A/10 S3	2	2	19	0.39	0.045	29	21	0.48	73	0.04	2	0.95	0.01	0.12	1	390
93A/10 S4	2	2	19	0.45	0.068	48	21	0.84	52	0.06	2	0.84	0.01	0.12	3	1880
93A/10 S5	4	2	14	0.33	0.048	42	15	0.51	38	0.04	2	0.83	0.01	0.08	1	1430
93A/10 S6	2	2	18	0.31	0.06	19	21	0.88	55	0.06	2	0.92	0.01	0.15	1	540
93A/10 S7	2	2	21	0.47	0.082	54	21	0.88	59	0.06	2	0.98	0.01	0.12	1	2340
93A/10 S8	2	2	17	0.29	0.081	20	18	0.82	52	0.05	2	0.78	0.01	0.12	1	550
93A/10 S9	2	2	18	0.29	0.069	23	21	0.83	55	0.06	2	0.88	0.01	0.14	1	830
93A/10 S10	2	2	16	0.3	0.052	24	17	0.54	48	0.05	2	0.69	0.01	0.11	1	970
93A/10 S11	2	2	25	0.4	0.052	84	27	0.74	129	0.09	2	1.13	0.01	0.19	1	1530
93A/10 S12	2	2	26	0.42	0.057	70	28	0.78	127	0.09	2	1.18	0.01	0.19	1	1600

sugary and is interspersed with quartz and potassium feldspar. Associated minerals include pyrite, molybdenite (up to 5 per cent), calcite, celestite, chalcopyrite and possibly barite. Galena, sphalerite, wolframite and scheelite have also been reported (Ball and Boggaram, 1984; McCammon, 1966). The sugary fluorite-quartz-feldspar rock grades into altered granitic gneiss which is generally pink to rusty in colour and contains pyrite, hematite, chlorite and, locally, a few per cent molybdenite. Mineralized zones are folded by late, broad, open upright folds and, locally, truncated by late faults (P.B. Read, personal communication, 1989).

ROCK GEOCHEMISTRY

High-grade fluorspar at Eaglet contains between 50 and 87 per cent CaF_2, 7 to 26 per cent SiO_2 (Table 10), approximately 300 to 700 ppm phosphate, less than 1 ppm arsenic and is enriched in strontium, containing greater than 6000 ppm. Dark purple fluorite is enriched in thorium and light rare-earths relative to the green and white varieties. Moderately to strongly altered gneiss contains between 3 and 35 per cent CaF_2, is enriched in strontium and locally contains anomalous concentrations of lead, zinc, molybdenum, light rare-earths and thorium. The moderately to strongly altered gneisses are generally depleted in sodium and potassium relative to their weakly altered counterparts. Veins peripheral to the main mineralized zones locally contain over 3 per cent lead, 1 per cent zinc and 10 per cent CaF_2 (Table 10).

STREAM-WATER AND SILT GEOCHEMISTRY

Statistical analysis of fluorine in waters collected as part of the Regional Geochemical Survey (RGS) indicates that thresholds separating background from anomalous populations are 130, 125 and 115 ppb for areas underlain by pelitic schists, till and granodiorites, respectively (Figure 9). Waters collected from Barrett Creek below the main mineralized zones and adit dumps contain in excess of 300 ppb fluorine and are clearly anomalous (Figure 17, Tables 11, 12). Silts collected downstream from mineralization contain in excess of 1500 ppm fluorine. Waters and silts collected immediately downstream from the first significant surface mineralization (Stations 9 and 10, Figure 17) are not enriched in fluorine. Water samples collected from rills draining the two adits contain extremely high fluorine and uranium values, 3000 and 150 ppb, respectively; silts from the rills contain moderate to high amounts of fluorine and are also slightly anomalous with respect to lead, zinc, strontium, thorium and lanthanum.

AGE AND GENESIS

Fluorite mineralization is associated with aplitic dikes which crosscut granitic gneisses associated with the Quesnel Lake orthogneiss. Mineralization is superimposed on the gneisses. Fluorite veins crosscut the granitic gneiss, fluorite locally replaces it and in areas of significant fluorite mineralization, the gneiss appears to have been subjected to pervasive potassic alteration. The presence of molybdenum and tungsten minerals associated with the fluorite imply a granitic source for the mineralizing fluids, and a greisen origin for mineralization is likely.

Fission-track dating on fluorite from Eaglet suggests an age of formation of 104.6±6 Ma (V. Harder, personal communication to Z.D. Hora, 1987). Fission-track studies on fluorite are in the very early stages of development and cannot be considered as irrefutable evidence. Preliminary K-Ar data from muscovite separates suggest an age of 127±4 Ma for the mineralizing event (J. Harakal, personal communication, 1988). Cretaceous quartz monzonite stocks and dikes with associated copper-molybdenum mineralization occur in the Quesnel Terrane (Figure 9) and mineralization at Eaglet may be related to this system.

ECONOMIC CONSIDERATIONS

Estimated reserves at Eaglet, 1.8 million tonnes of 15 per cent CaF_2, are currently subeconomic. Much higher grade material is present, but coherent high-grade zones have not been defined. Arsenic levels are extremely low and, with beneficiation, silica and phosphorous contents might be lowered sufficiently to produce a marketable concentrate.

MAJOR FLUORSPAR DEPOSITS IN NORTHERN BRITISH COLUMBIA

LIARD FLUORITE

MINFILE No. 094M 002, 005, 006, 007, 008, 010, 011, 012, 013, 014, 015

The Liard fluorite showings, which are the most significant fluorite prospects in northern British Columbia, if not the whole province, occur within the Foreland Belt, near the British Columbia - Yukon border. They are exposed in a zone which begins approximately 3 kilometres north of Liard Hotsprings Provincial Park, Mile 497 on the Alaska Highway, and extends northwards for approximately 16 kilometres (Figure 18), from latitude 59°27'N to latitude 59°34'30''N at longitude 126°05'W. The terrain consists of low, heavily drift covered, rolling hills of the Liard Plateau and outcrop is sparse. Local karst topography is developed, with sink holes and isolated buttes sporadically distributed. Two major fires passed through the area, one in 1971 and the other in the early 1980s; the forests now consist of standing deadwood, abundant deadfall and a thick new growth. Old roads and trails lead from the Alaska Highway to the showings which are at elevations ranging from 730 to 1100 metres (2400 to 3600 feet); however, in places the trails are so badly overgrown and covered with deadfall that they are virtually impassable, even on foot, and access to the showings is most easily gained by helicopter.

HISTORY

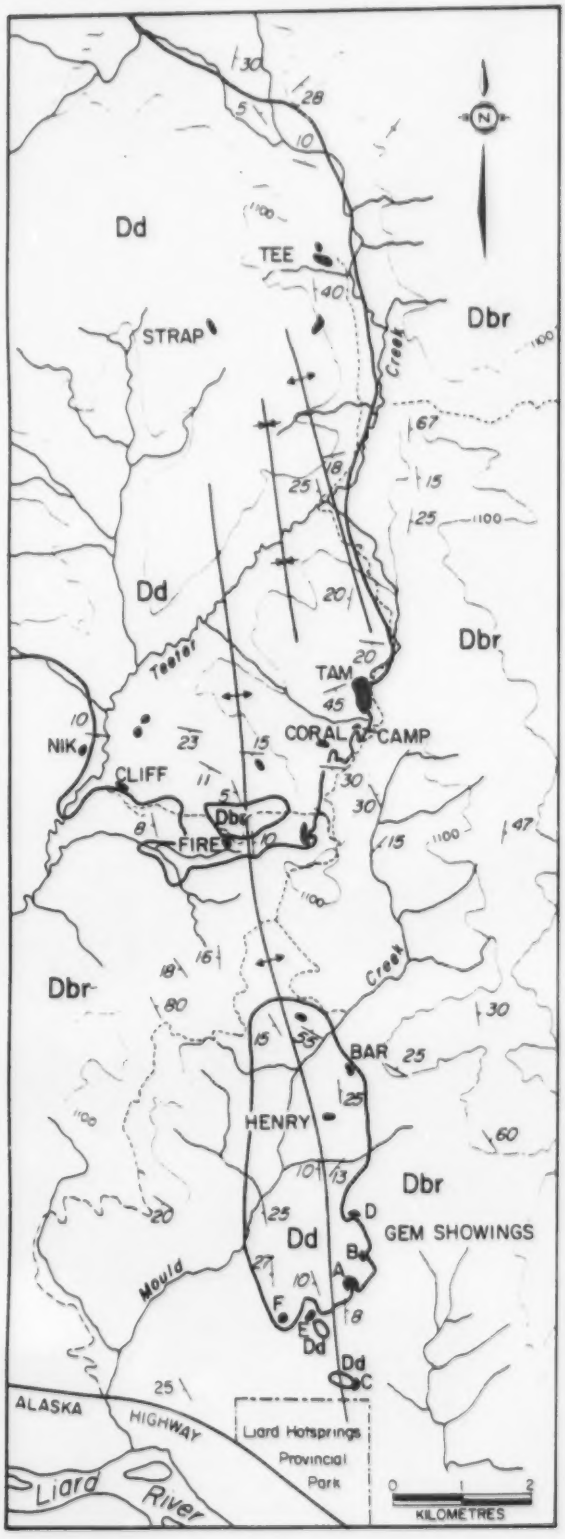
The Gem showings, the most southerly of the Liard Hotspring fluorspar occurrences, were discovered in 1953 by prospectors in search of uranium mineralization (Holland, 1955). In 1954 work was begun, which included road building, stripping, drilling and geological mapping. Regional prospecting in 1971 resulted in the discovery of the northern showings which were drilled and extensively explored during 1971 and 1972. Grades in excess of 30 per cent CaF_2 were encountered over excellent widths and thicknesses; however, high predicted production and transportation costs to bring a fluorspar concentrate to the market resulted in little work being done after the early 1970s. In 1986, the Liard fluorspar showings were restaked as the Thor claims.

GEOLOGY

The area north of Liard Hotsprings is underlain by Middle Devonian Dunedin Formation fossiliferous limestones and Middle to Upper Devonian Besa River shales (Taylor and MacKenzie, 1970). The Dunedin Formation is exposed in the core of a broad, open antiform with a north-trending axis (Figure 18). It is medium to dark grey in colour and locally extremely fossilliferous, containing abundant colonial corals as well as brachiopods and gastropods. The overlying Besa River Formation consists predominantly of black shale, some calcareous shales and minor thin buff dolomitic layers. The contact between the shales and limestones is very irregular, possibly as a result of an erosional disconformity or structural complications (Woodcock, 1972).

Mineralization, which consists predominantly of fluorite and witherite, occurs at or near the contact between the shales and the limestones. In most of the showings, the most significant mineralization occurs in the limestones beneath the contact; in some cases, minor amounts of fluorite and witherite are found in the shales overlying mineralized limestone; and, rarely, such as at the Gem E showings, mineralization is confined to the shales (Woodcock, 1972; Woodcock and Smitheringale, 1955). Fluorite and witherite commonly occur as infillings and replacements in limestone or shale breccias, or as fracture fillings in the surrounding limestones and shales. In some cases, such as at the Tee showing, individual replacement pods, devoid of hostrock fragments, are exposed over areas in excess of 50 by 15 metres; at the Tam showing mineralization is exposed over an area 275 metres in length by 50 to 165 metres in width.

In addition to fluorspar and witherite, mineralized zones contain barytocalcite, minor barite and silica. In most of the showings the fluorite is purple to black in colour and may be fine or coarse grained. In the Gem A showing the fluorite has been bleached to rose and white on exposed surfaces, but is dark purple on fresh surfaces. At the Tee showing, most of the fluorite is colourless, as is reportedly the case at the Cliff prospect (Woodcock, 1972). The witherite is usually white; however in shale-hosted mineralization, witherite tends to be grey. In some locations, witherite is more abundant than fluorite, in others, the opposite is the case. Together, they commonly comprise 60 to 75 per cent of the rock. Barite rarely comprises more than 10 per cent (Woodcock and Smitheringale, 1955).



LEGEND

DEVONIAN OR YOUNGER

Dbr — BESA RIVER FORMATION - black shale, calcareous shale, minor dolomite

Dd — DUNEDIN FORMATION - limestone, fossiliferous limestone

FLUORSPAR IN OUTCROPS

FLUORSPAR SHOWINGS

[1]No.	RANK	NAME	MINFILE No.
097	01	Gem	094M002
098	02	Gem E	094M015
099	02	Bar	094M013
100	02	Henry	094M014
101	01	Tam	094M005
102	02	Fire	094M006
103	01	Coral	094M007
104	02	Camp	094M008
105	01	Tee	094M010
106	02	Strap	094M011
107	03	[2]Nik	094M012
108	03	[3]Cliff	Not listed

Rank
1: Major Fluorspar Occurrences
2: Deposits With Significant Fluorspar
3: Deposits With Minor Associated Fluorspar

[1]See appendix
[2]also called Nick
[3]also called Teaser

SYMBOLS

GEOLOGIC CONTACT

15 — BEDDING

ANTICLINE, SYNCLINE TRACE

CONTOUR

Figure 18. Generalized geology of the Liard fluorspar showings. Modified from Woodcock, 1972 and, Woodcock and Smitheringale, 1955.

TABLE 13
ROCK GEOCHEMISTRY, LIARD FLUORITE AND MILE 397 BARITE

SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	BaO	LOI	F	CaF2
LR88-1B	2.24	<0.01	0.39	0.63	<0.01	0.21	54.34	0.26	0.04	0.03	7.98	3.87	36.84	73.84
LR88-1C	0.72	<0.01	0.30	0.51	<0.01	0.16	13.40	0.18	0.02	0.02	42.40	2.92	7.20	14.78
LR88-2A	1.47	<0.01	0.36	0.57	<0.01	0.17	64.89	0.28	0.01	0.02	0.93	0.55	40.96	84.16
LR88-2C	0.78	0.01	0.32	0.58	0.01	0.22	24.82	0.20	0.01	0.02	43.30	16.01	12.00	24.66
LR88-2D	0.44	<0.01	0.02	<0.01	<0.01	0.02	5.23	0.08	0.01	0.04	61.80	0.21	3.52	7.23
LR88-2E	3.89	<0.01	0.08	0.03	<0.01	<0.01	51.81	0.11	0.03	0.03	18.50	5.53	35.94	73.84
LR88-5A	3.39	<0.01	0.07	0.01	<0.01	<0.01	55.50	0.11	0.03	0.04	18.00	4.48	35.94	73.84
LR88-5B	4.14	<0.01	0.08	<0.01	<0.01	<0.01	48.92	0.10	0.02	0.04	22.40	5.82	35.84	73.64
LR88-5D	0.85	<0.01	0.04	0.01	<0.01	<0.01	50.68	0.11	0.01	0.04	23.10	7.87	34.58	71.01
LR88-6B	55.85	0.07	1.44	0.49	<0.01	0.03	4.90	0.08	0.22	0.05	23.40	4.87	3.23	6.64
LR88-7B	1.84	<0.01	0.07	0.02	<0.01	<0.01	24.80	0.08	0.01	0.04	58.00	13.94	18.24	7.50
LR88-7C	1.00	<0.01	0.18	0.08	<0.01	<0.01	42.52	0.12	0.01	0.04	31.50	8.16	32.00	65.76
LR88-7D	0.62	<0.01	0.10	0.01	<0.01	<0.01	93.15	0.12	0.01	0.03	8.40	2.07	47.87	98.38

SAMPLE NO.	Au	Ag	As	Sb	Mo	Pb	Zn	Ni	Cr	Sn	Cs	Sc	Zr	
LR88-1B	<5	<5	<1.0	<.2	<2	3	31	<20	<50	<5	<1.0	<.5	28	
LR88-1C	<24	<5	<20.0	<.2	38	3	9	<20	<50	<5	1.8	<.5	<5	
LR88-2A	<5	<5	<1.0	<.2	<2	3	7	<20	<50	27	<1.0	<.5	81	
LR88-2C	<20	<5	<17.0	0.3	27	5	185	<20	90	<5	1.3	<.5	<5	
LR88-2D	<31	<5	<26.0	<.2	52	3	4	<20	100	12	1.8	<.5	<5	
LR88-2E	<5	<5	<1.0	<.2	8	3	13	<20	<50	<5	<1.0	<.5	<5	
LR88-5A	<5	<5	<1.0	0.6	8	3	13	<20	74	<5	<1.0	<.5	48	
LR88-5B	<9	<5	<1.0	0.2	<4	3	9	<20	<50	13	<1.0	<.5	<5	
LR88-5D	<5	<5	<1.0	<.2	9	3	5	<20	130	<5	<1.0	<.5	46	
LR88-6B	<11	<5	<1.0	0.5	28	3	98	<20	<100	<5	<1.0	0.9	X	
LR88-7B	<22	<5	<17.0	<.2	33	3	11	<20	130	<5	1.8	<.5	X	
LR88-7C	<12	<5	<1.0	<.2	10	3	8	<20	<110	10	1.1	<.5	X	
LR88-7D	<5	<5	<1.0	<.2	3	3	8	<20	83	<5	<1.0	<.5	42	

SAMPLE NO.	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
LR88-1B	<5	<32	0.4	<2	<1.0	<5	<.5	<5	1.7	1.4	<10	1200	<5	<1.0
LR88-1C	<5	<33	<.2	<2	<1.0	<5	<.5	<5	1.2	<2.5	<10	8400	20	<1.0
LR88-2A	<5	<10	0.3	<2	<1.0	<5	<.5	20	0.8	2.8	<10	185	14	<1.0
LR88-2C	15	<28	<2.1	<2	<1.0	<5	<.5	<5	<0.5	92.3	<10	4900	40	<1.0
LR88-2D	<5	<40	<.2	<2	<1.0	<5	<1.2	<5	1.3	<3.1	<10	7200	55	<1.0
LR88-2E	<5	<48	0.3	<2	<1.0	<5	<.5	<5	<1.1	1.8	<102	900	23	<1.0
LR88-5A	<5	<41	0.4	<2	<1.0	<5	<.5	<5	<0.5	<0.5	<10	2800	20	<1.0
LR88-5B	<5	<51	0.3	<2	<1.0	<5	<.5	<5	<1.2	<0.5	<10	4100	27	<1.0
LR88-5D	<5	<50	0.3	<2	<1.0	<5	<.5	<5	<1.2	<0.5	<10	2800	20	<1.0
LR88-6B	<5	<57	0.4	<2	<1.0	<5	<.5	<5	1.7	3.5	<10	>10000	20	<1.0
LR88-7B	<5	<29	<.2	<2	<1.0	<5	<.5	<5	<0.5	<2.2	<10	9000	20	<1.0
LR88-7C	<5	<63	<.2	<2	<1.0	<5	<1.1	<5	<1.5	<0.5	<10	5900	20	<1.0
LR88-7D	<5	<28	0.4	<2	<1.0	<5	<.5	<5	<0.5	0.9	<10	1600	48	<1.0

Major element data in per cent, trace elements in parts per million except Au, which is in parts per billion. Sample descriptions as follows: LR88-1B purple fluorite, Mi.397 Barite; LR88-1C barite-fluorite vein, Mi.397 Barite; LR88-2A pure purple fluorite, chip sample, Liard TAM showing; LR88-2C witherite-fluorite vein, Liard TAM showing; LR88-2D witherite vien/replacement with trace fluorite; LR88-2E fluorite-rich vein/replacement, Liard TAM showing; LR88-5A pale to dark purple fluorite, Liard GEM A showing; LR88-5B typical fluorite-witherite vein/replacement, Liard GEM A showing; LR88-5D coarse-grained fluorite vein, Liard GEM A showing; LR88-6B shale breccia with fluorite, Liard GEM E showing; LR88-7B composite vein sample, Liard TEE showing; LR88-7C fluorite-rich vein material, Laird TEE showing; LR88-7D pure fluorite, Liard TEE showing.

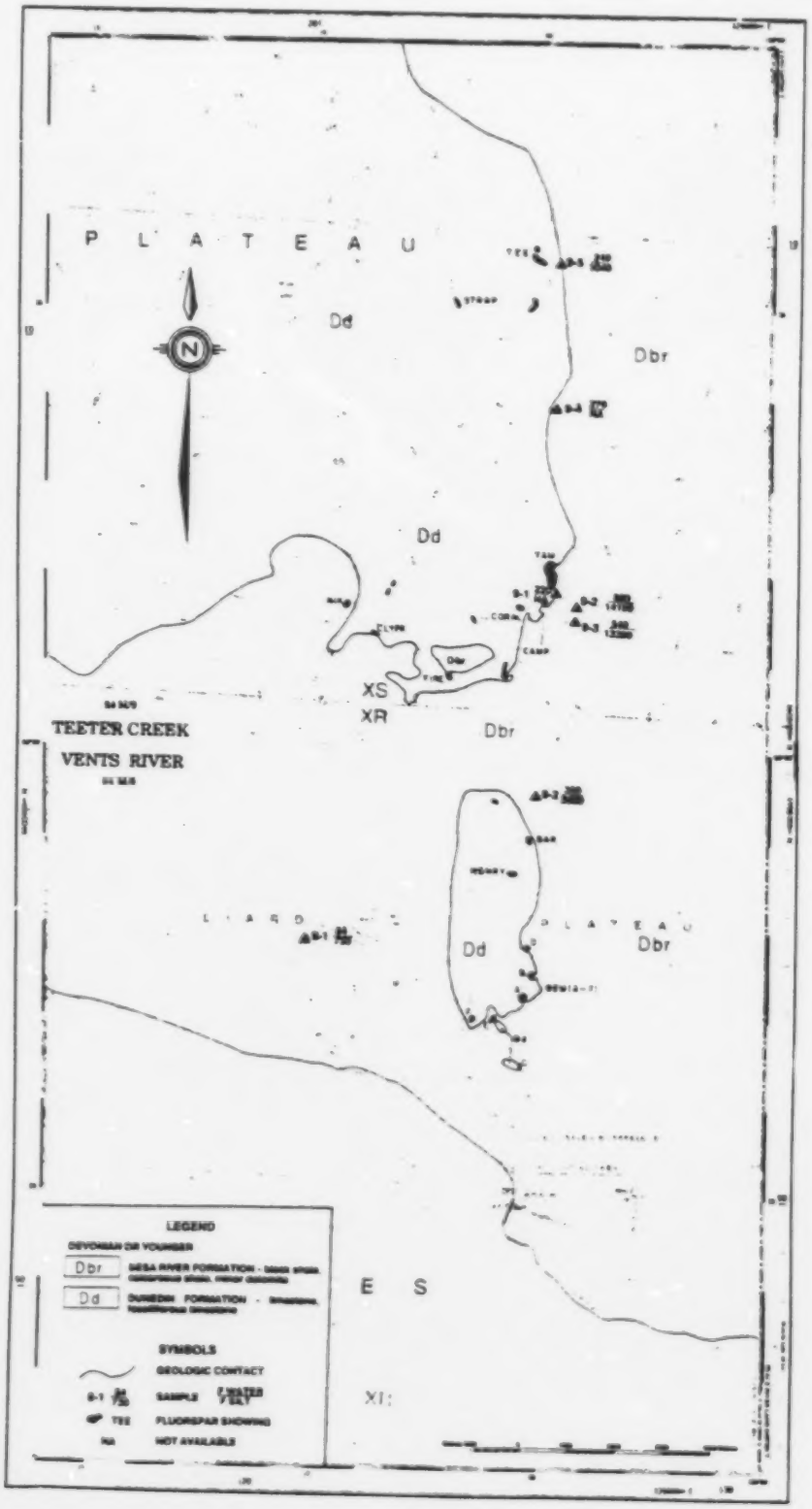


Figure 19. Fluorine-in-water and silts, Liard area.

TABLE 14
STREAM-WATER CHEMISTRY, LIARD HOTSPRINGS AREA

SAMPLE NO.	U ppb	F ppb	pH
94M/8-1	0.02	84	7.8
94M/8-2	2.2	300	8.1
94M/9-1	0.02	220	7.2
94M/9-2	4.3	880	7.9
94M/9-3	2.7	540	8.1
94M/9-4	1.5	270	8.2
94M/9-5	1.3	240	8.1
94N/12-1	1.2	1600	7.9

ROCK GEOCHEMISTRY

Hand-cobbed fluorspar samples from the Liard Tam, Tee, and Gem A showings and from Mile 397 Barite contained 35 to 48 per cent fluorine (approximately 74 to in excess of 98 per cent CaF_2), 1 to 16 per cent barium, up to 3.5 per cent silica and low phosphorus and arsenic (Table 13). Representative vein and replacement samples contained 12 to 36 per cent fluorine (approximately 25 to 74 per cent CaF_2), 18 to 58 per cent barium, approximately 1 to 4 per cent silica and low phosphorus and arsenic. All material is moderately to strongly enriched in strontium, locally containing in excess of 1 per cent.

STREAM-WATER AND SILT GEOCHEMISTRY

Samples collected downstream from the Liard Hotspring fluorite showings contain greater than 230 ppb fluorine in waters and greater than 1000 ppm fluorine in silts (Figure 19, Tables 14, 15). Silts downstream from fluorspar showings are also somewhat enriched in barium, molybdenum, zinc, arsenic, vanadium and boron, and waters contain anomalous uranium concentrations (to 4.3 ppb).

AGE AND GENESIS

Fluorspar showings at Liard Hotsprings consist predominantly of carbonate-breccia-hosted infilling and replacement mineralization. The breccias do not appear to be clearcut paleokarst solution breccias, they may have formed as a result of small-scale dissolution or hydraulic fracturing. Preliminary examination indicates that hydrogen sulphide gas is present within fluid inclusions in the fluorite grains. In terms of stratigraphic setting and the nature of the host breccias, these showings are similar to the lead-zinc deposits in the Robb Lake - Redfern Lake belt to the south (MacQueen and Thompson, 1978). They may be genetically similar as well, formed from solutions originating during dewatering of the sedimentary basin, but represent fluorine and barium-rich, sulphur-deficient (barium carbonate rather than barium sulphate present) end-members as opposed to the lead-zinc-sulphur end-member. If this is the case, the Liard Hotspring deposits are probably approximately the same age as the carbonate-hosted lead-zinc deposits in the Robb Lake belt. Lead isotope evidence suggests that mineralization associated with those deposits formed near 370±30 Ma (Godwin *et al.*, 1982). Fission-track studies in fluorite from the Gem showing suggest an age of formation of 332±56 Ma (V.

TABLE 15
STREAM-SEDIMENT GEOCHEMISTRY, LIARD HOTSPRINGS (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb	Bi
94M/8 S1	2	42	16	148	0.8	44	12	272	3.02	5	5	0	2	60	1	2	2
94M/9 S2	8	26	9	330	0.3	47	7	154	1.63	26	5	0	1	110	3	3	3
94M/9 S3	9	28	10	613	0.3	130	7	388	1.93	18	5	1	2	84	7	4	2
94M/9 S4	8	32	12	261	0.8	60	8	128	2.79	13	5	0	3	50	2	3	2
94M/9 S5	3	26	12	183	0.7	34	5	132	1.44	5	5	1	2	36	1	4	2
94N/12 S1	1	2	2	111	0.2	5	3	180	0.16	5	5	1	1	727	1	2	2

SAMPLE NO.	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
94M/8 S1	22	2.63	0.038	5	29	0.72	608	0.01	4	1.16	0.01	0.04	1	730
94M/9 S2	104	17.76	0.119	5	14	0.67	1383	0.01	19	0.87	0.02	0.24	1	14100
94M/9 S3	147	8.86	0.116	6	21	0.64	1261	0.01	26	1.33	0.02	0.29	1	13300
94M/9 S4	78	1.61	0.091	9	26	0.42	812	0.01	12	1.12	0.01	0.15	1	2600
94M/9 S5	26	4.44	0.071	7	14	2.25	620	0.01	9	0.82	0.01	0.06	1	1040
94N/12 S1	1	22.86	0.001	2	1	0.29	116	0.01	3	0.03	0.01	0.01	1	1360

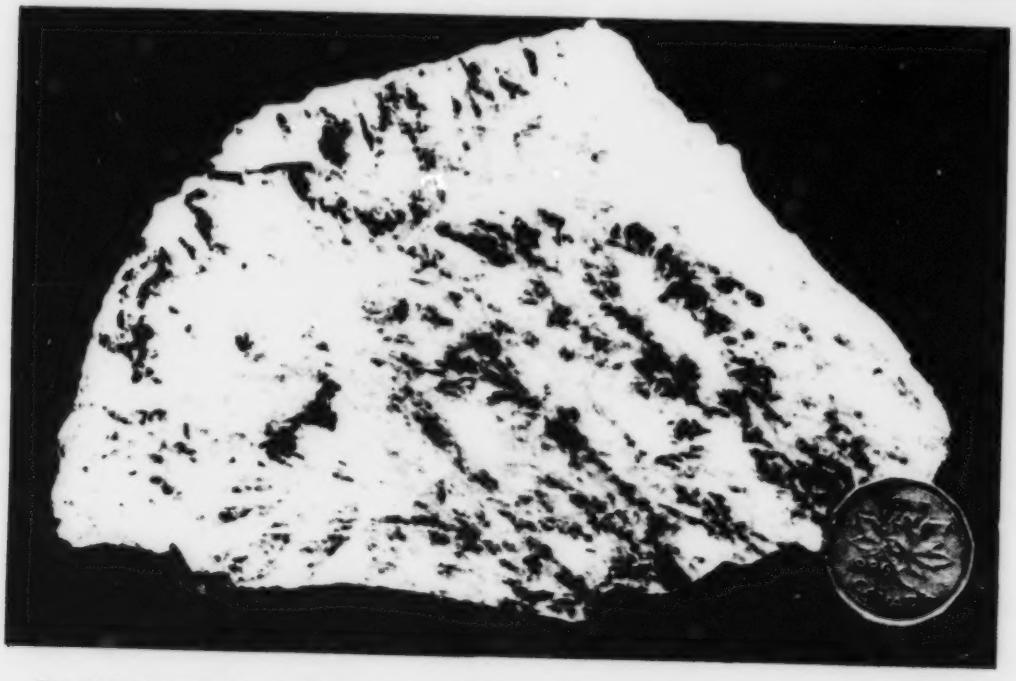


Plate 8. Dark purple fluorite present in spaces between coarsely crystalline barite blades, Mile 397 Barite.

TABLE 16
STREAM-WATER CHEMISTRY,
MILE 397 BARITE

SAMPLE NO.	U ppb	F ppb	pH
94K/10-1	0.65	38	8.2
94K/10-2	0.44	46	8.1
94K/10-3	0.97	420	8.3
94K/10-4	0.83	360	8.2
94K/10-5	0.74	380	8.1
94K/10-6	1.6	700	8.2
94K/10-7	4.0	690	8.3

TABLE 17
STREAM-SEDIMENT GEOCHEMISTRY, MILE 397 AREA (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb	Bi	V
94K/10 S1	1	2	11	28	0.1	8	2	129	0.29	4	5	1	1	61	1	2	2	6
94K/10 S2	1	1	7	16	0.1	6	2	116	0.31	6	5	1	1	46	1	2	2	6
94K/10 S3	1	1	9	44	0.1	9	3	131	0.29	6	5	1	1	86	1	2	2	9
94K/10 S4	2	4	16	83	0.1	16	4	126	0.64	5	5	0	1	71	1	2	2	9
94K/10 S5	3	8	20	106	0.1	30	6	199	0.71	7	5	0	1	87	1	2	2	15
94K/10 S6	1	1	9	48	0.1	12	5	100	0.26	2	5	1	1	80	1	3	2	8
94K/10 S7	11	26	16	266	0.8	62	8	98	1.82	10	5	0	3	92	4	3	2	46

SAMPLE NO.	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
94K/10 S1	13.89	0.008	2	2	5.91	398	0.01	5	0.07	0.01	0.02	1	430
94K/10 S2	14.9	0.008	2	2	6.83	288	0.01	2	0.08	0.01	0.02	1	280
94K/10 S3	18.83	0.007	2	4	5.6	1483	0.01	8	0.26	0.01	0.11	1	7620
94K/10 S4	16.33	0.009	3	4	4.76	1430	0.01	7	0.20	0.01	0.08	1	2540
94K/10 S5	17.4	0.009	3	6	5.18	1766	0.01	11	0.36	0.01	0.12	1	3040
94K/10 S6	15.79	0.008	2	3	3.14	1767	0.01	6	0.27	0.01	0.12	1	14800
94K/10 S7	7.98	0.088	5	38	1.29	758	0.01	21	0.99	0.01	0.20	1	3790

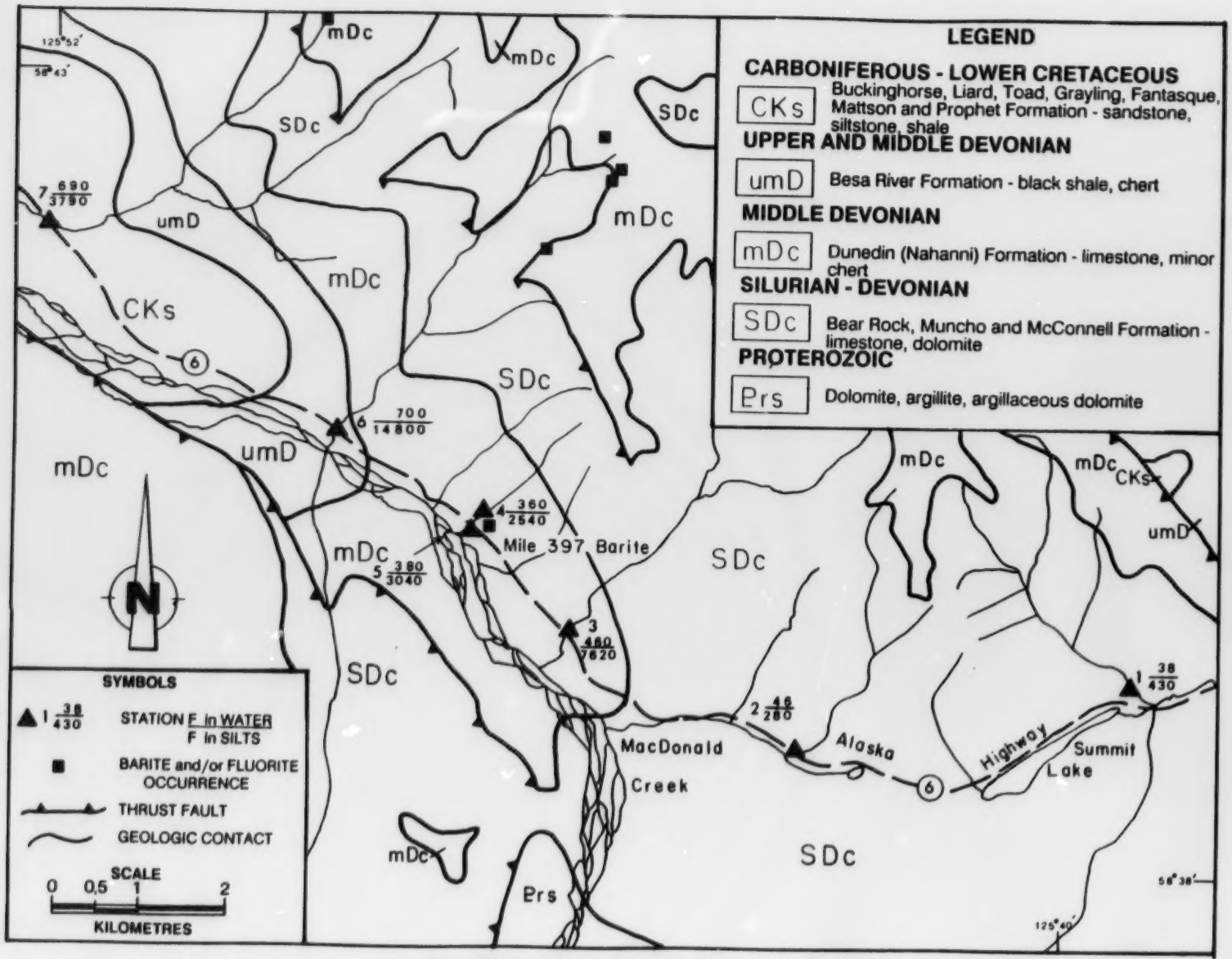


Figure 20. Geology and fluorine-in-water and silts, Mile 397 area.

Harder, personal communication to Z.D. Hora, 1987) which, within errors, is in agreement with the lead-lead data from Robb Lake.

Other Related Deposits

Fluorite and barite-fluorite showings are present near the contact between the Devonian Dunedin and Besa River formations for over a hundred kilometres to the south and east of the Liard Hotspring prospects. The Mile 397 Barite occurrence (MINFILE No. 094K 004), located between Mile 397 and 398 on the Alaska Highway, is one such showing. A large pod of barite, hosted in thin bedded, dark grey, bituminous limestone, is exposed in a canyon wall approximately 100 metres north of the highway. Barite replaces limestone, and is also present in veins and as breccia and solution cavity infillings. Barite rosettes or blades in limestone are common. Purple fluorite is present in barite veins, in solution cavity infillings and between barite blades in coarse, crystalline barite accumulations (Plate 8).

Geochemical samples collected in the Mile 397 area, from drainages in which fluorspar mineralization is present, contain greater than 350 ppb fluorine in waters and greater than 2500 ppm fluorine in silts (Figure 20, Tables 16, 17). As was the case at Liard, silts from mineralized drainages are anomalous in barium, and in some cases, zinc, vanadium and boron contents are also elevated.

Economic Considerations

Significant widths and thicknesses of fluorspar mineralization grading in excess of 30 per cent CaF_2 have been reported from the Liard area. The showings have extremely low phosphorus and arsenic contents, and moderately low silica. Beneficiation studies by Canmet, involving dry grinding and two-stage flotation, produced a fluorite concentrate analyzing 98.5 per cent CaF_2 and a barite-witherite concentrate analyzing 87.6 per cent $BaSO_4/BaCO_3$ (Collings and Andrews, 1988). Distance from market appears to be the major factor governing the economic potential of the Liard fluorspar properties.

OTHER FLUORSPAR OCCURRENCES IN SOUTHERN BRITISH COLUMBIA

SIGNIFICANT MINERALIZATION

A large number of fluorspar occurrences exist within the province (Figures 1, 2), but due to the unfavourable economics of mining in remote areas, only those in southern areas are included in this report. Nevertheless, fluorspar occurrences in the Atlin area should be examined as proximity to tidewater could make them economically viable. A number of the occurrences in the southern part of the province are briefly described following.

GYPO, OLIVER SILICA (MINFILE 082ESW084):

Colourless to pale green fluorite occurs as small pods near the centre of the Gypo (Oliver) silica quarry, north of the town of Oliver at latitude 49°11'40'N, longitude 119°33'20W. The quarry is located on a large quartz vein which crosscuts quartz monzonite. The vein contains few impurities, other than the fluorite pods which have exposed surfaces of 0.5 to 1 metre by 1.5 to 2 metres in size. The silica quarry has operated intermittently since 1926, and in 1958 approximately 29 tonnes of fluorite were shipped to markets in Washington (McCammon and James, 1959).

WHITEMAN CREEK (MINFILE 082LSW001):

A fluorite occurrence on Whiteman Creek (latitude 50°20'N, longitude 119°20'W), near the west shore of Okanagan Lake, opposite Vernon, was explored for fluorite in the mid-1960s (McCammon, 1968b). Mineralization is exposed over an area of at least 300 by 700 metres and occurs as fracture fillings and drusy quartz-fluorite veins, averaging 1 to 10 centimetres wide, in quartz monzonite (Plate 9). Veins are characterized by rapid pinching and swelling and rarely approach 1 metre in width. Open spaces are common and usually lined with small, well-formed fluorite crystals. The fluorspar is present in radiating aggregates most commonly green in colour, although colourless, rose and pale purple varieties are sometimes intermixed with the green. Pyrite is a minor component of the veins and no other sulphides were observed or reported.

GALENA FARM (MINFILE 082FNW067):

Fluorite is a common gangue mineral, together with quartz and siderite, in lead-zinc-silver veins of the Galena Farm mine at Silverton in the Slocan district (latitude 49°56'N, longitude 117°22'W). The veins occur predominantly within the Nelson granite, near its northern margin. Mineralization occurs as open-space fillings and fracture coatings. Quartz is present in the gangue in amounts approximately equal to, or slightly greater than fluorite; siderite is a minor constituent. The veins commonly have repeated layers of small quartz or fluorite crystals distributed parallel to vein margins; small well-formed fluorite crystals lining drusy openings; or, occasionally, botryoidal accumulations of fluorite adjacent to vein openings. The fluorspar at Galena Farm is colourless to very pale purple. Obvious sulphide minerals present are galena, sphalerite and pyrite, in that order of abundance.

Statistical analysis of fluorine-in-water data from NTS 82F (Figure 5) indicates that the threshold value which separates anomalous from background populations is 136 ppb for drainages underlain by granitic rocks. In the vicinity of the Galena Farm mine, stream waters contain anomalous amounts of fluorine, generally in excess of 250 ppb (Figure 21, Table 18). Stream sediments also contain elevated fluorine levels, greater than 1700 ppm, and high concentrations of lead, zinc and silver (Figure 21, Table 19). Waters collected from a rill draining an old adit contained extremely elevated fluorine levels (1900 ppb); silts collected from the rill contained high lead, zinc and iron, but only moderate amounts of fluorine (520 ppm).

TABLE 18
STREAM-WATER CHEMISTRY, GALENA FARM AREA

SAMPLE NO.	U ppb	F ppb	pH
82F/14-1	3.0	1900	8.0
82F/14-2	0.43	320	7.9
82F/14-3	0.45	300	7.7
82F/14-4	0.45	290	7.8
82F/14-5	0.46	260	7.8
82F/14-6	0.94	340	7.8

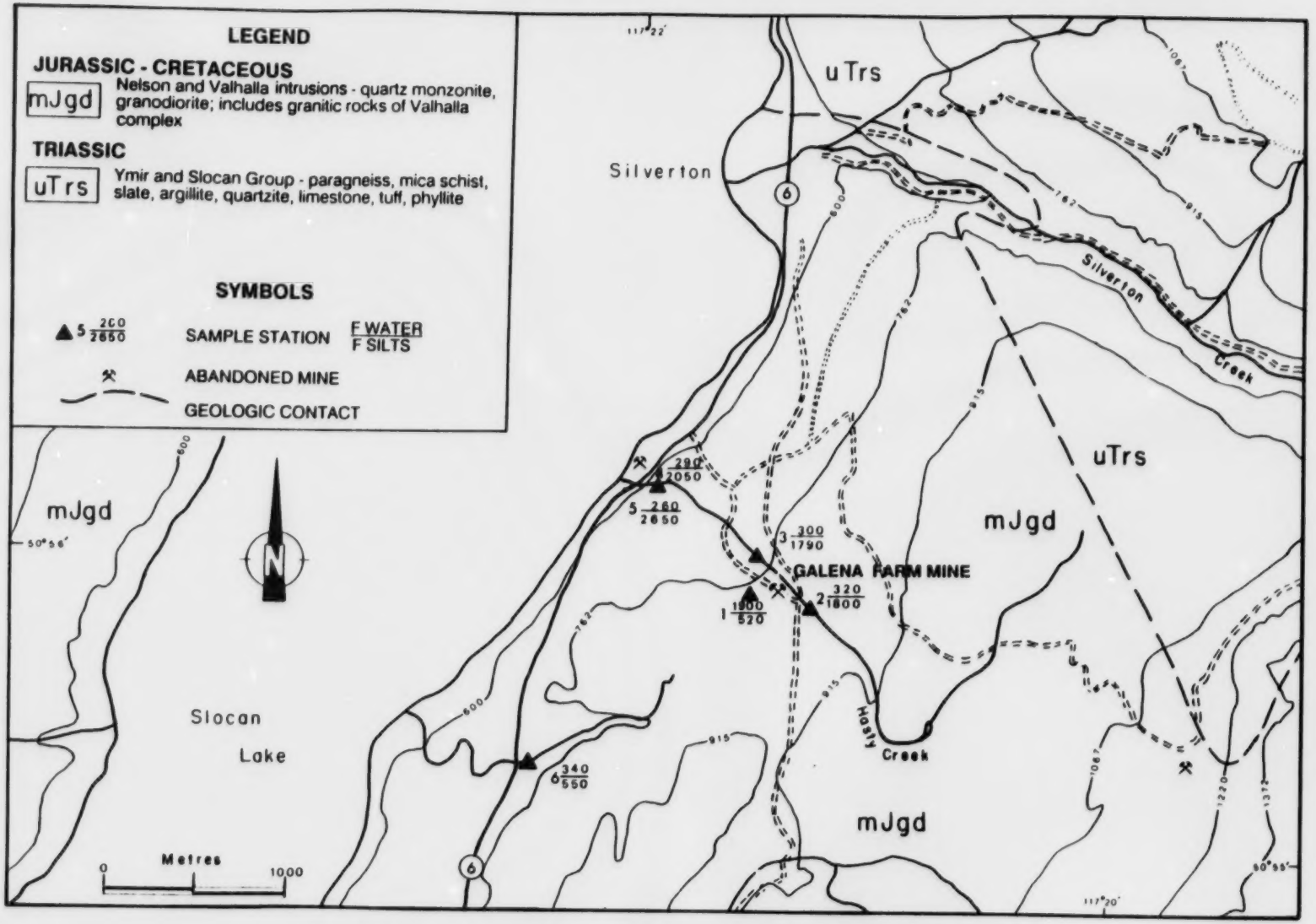


Figure 21. Geology and stream water and silt geochemistry - Silverton-Galena Farm area.

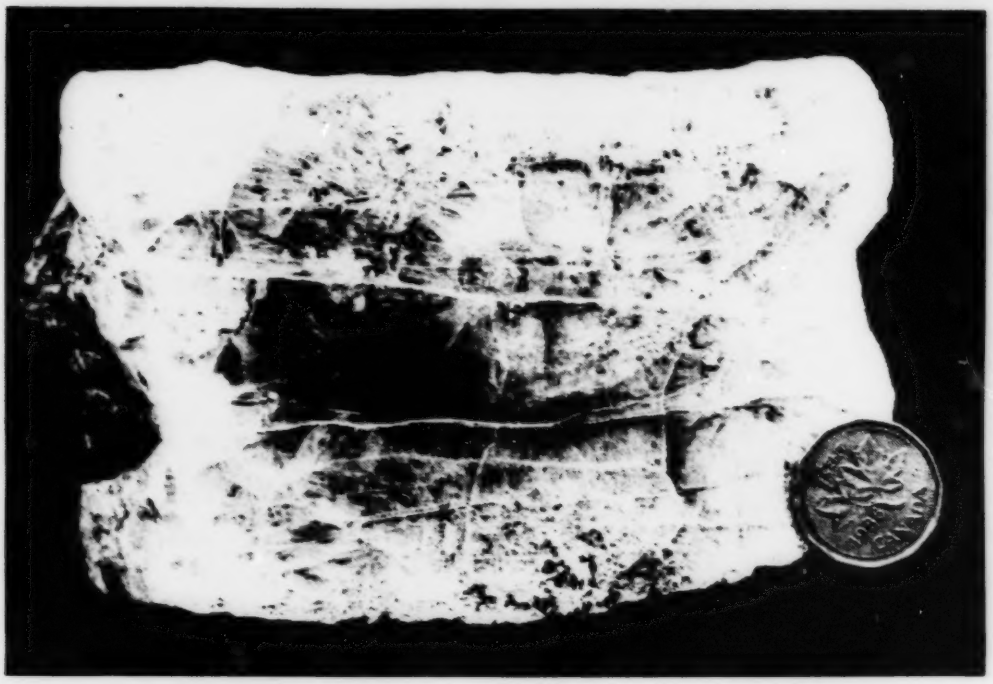


Plate 9. Radiating texture in pale green fluorite vein material, Whiteman Creek fluorite property.

TABLE 19
STREAM-SEDIMENT GEOCHEMISTRY, GALENA FARM (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb
82F/14 S1	3	62	1949	918	0.7	72	16	850	7.48	50	5	0	3	107	18	2
82F/14 S2	1	15	130	327	4.2	17	6	340	1.88	6	5	0	5	38	2	2
82F/14 S3	1	15	86	376	2.1	19	5	385	1.81	10	5	0	6	38	3	2
82F/14 S4	1	22	239	1263	7.0	24	7	456	2.20	23	5	0	7	40	8	2
82F/14 S5	2	28	266	1184	17.9	21	7	412	2.16	37	5	0	6	36	8	3
82F/14 S6	1	23	20	140	0.9	30	7	447	1.79	5	5	0	2	42	2	2

SAMPLE NO.	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
82F/14 S1	2	26	0.80	0.050	12	14	0.34	113	0.04	2	0.68	0.01	0.07	1	520
82F/14 S2	2	38	0.82	0.138	31	25	0.47	36	0.06	2	0.77	0.01	0.07	1	1800
82F/14 S3	2	35	0.50	0.097	28	27	0.52	40	0.06	2	0.82	0.01	0.07	1	1790
82F/14 S4	2	43	0.58	0.095	28	28	0.58	34	0.06	2	0.90	0.01	0.07	1	2060
82F/14 S5	2	42	0.85	0.122	27	26	0.52	35	0.06	6	0.83	0.01	0.06	1	2650
82F/14 S6	2	37	0.44	0.058	13	22	0.38	76	0.04	2	0.85	0.01	0.05	1	550

REDBIRD (MINFILE 092ISE179):

Fluorite is abundant in veins cutting Triassic Nicola Group volcanics of the eastern Intermontane Belt, on the Redbird claim, near Stump Lake, south of Kamloops (latitude 50°23'30"N, longitude 120°22'W) and has been exploited by mineral collectors since the mid-1960s. Veins in the area vary from a few centimetres to a few metres in width and may comprise crystalline quartz and fluorite, chalcedonic quartz and fluorite, chalcedonic quartz and fluorite breccias cemented by crystalline quartz, or banded chalcedonic quartz, pyrite and minor fluorite. Anomalous gold values have been found associated with some veins in this area (Dekker, 1983). Open spaces are common within the veins and are frequently lined with coarse crystalline fluorspar. On the Redbird property, the

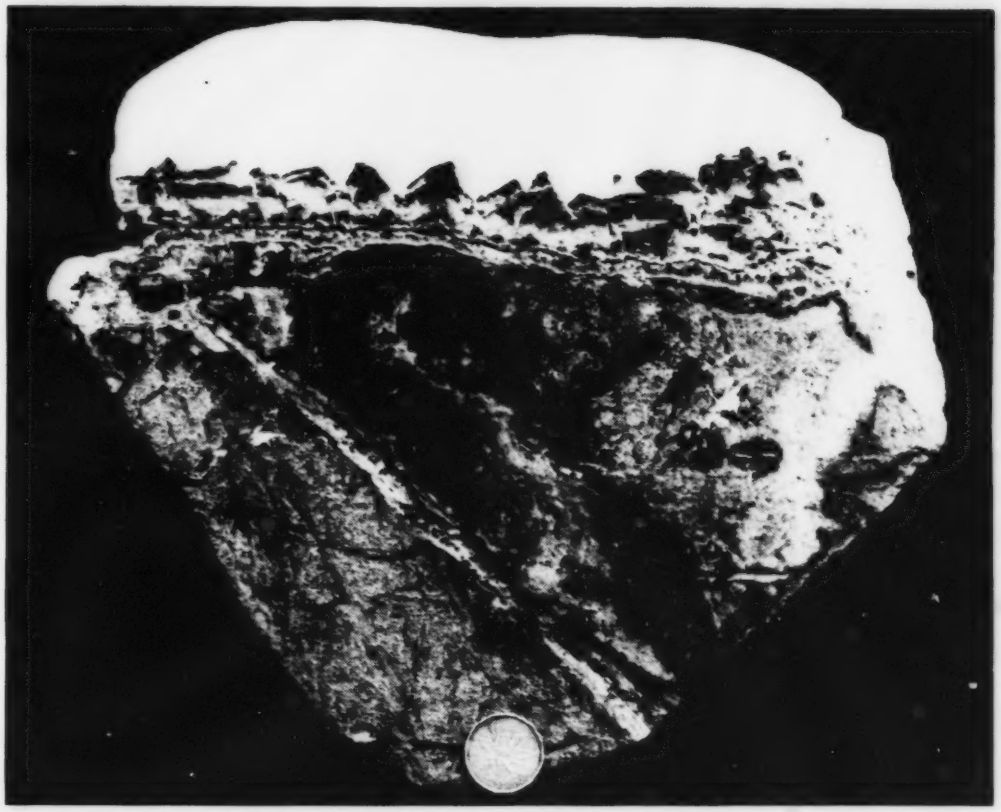


Plate 10. Epithermal vein, Redbird property. Crystalline purple fluorite, displaying well-developed growth zones, lines edges of vein adjacent to altered Nicola Group volcanics. Banded chalcedonic quartz forms the core of the vein. The opposite vein margin is missing.

fluorite is predominantly dark purple, but some dark green varieties are also present. In some veins, fluorite occurs along both vein walls adjacent to the Nicola volcanics (Plate 10), in others the fluorite forms the centre of veins with a vein border of chalcedonic quartz. In one vein, dark green fluorite forms bands adjacent to both the vein walls, followed by purple fluorite, then banded chalcedony and a core of crystalline quartz.

ROCK GEOCHEMISTRY

Fluorspar-rich samples (85 per cent CaF_2) from vein deposits at Oliver Silica, Whiteman Creek, Galena Farm and Redbird have low to moderate silica contents (1.66 to 5.52 per cent), and low phosphorus (except at Galena Farm where P_2O_5 concentrations reach 1100 ppm). Fluorspar from Whiteman Creek and Redbird also have low arsenic levels; no data available from the other two deposits (Table 20).

The trace element geochemistry of these deposits shows a number of features in common; all have low strontium contents, generally significantly less than 1000 ppm, and contain insignificant amounts of rare-earths and most other trace elements (Table 20). At Galena Farm, significant amounts of zinc, lead, copper and silver are present locally.

OTHER AREAS

A number of other occurrences, where fluorspar is present in significant amounts are reported from southern British Columbia, including the Tappen Creek (MINFILE 082LNW049) and To (MINFILE 082LNW034) properties near Shuswap Lake, and the Howell Creek property (MINFILE 082GSE037), which is associated with syenites in the Flathead region of southeastern British Columbia. Fluorite is also reported from Lower Cambrian carbonate-hosted, stratiform lead-zinc deposits in the Monashee Complex near Revelstoke (the Ruddock Creek deposit) and from molybdenum deposits in the Jordan Creek - Mount Copeland area, also near Revelstoke. Because of time constraints these were not visited, but brief descriptions are included in Appendix 1.

TABLE 20
ROCK GEOCHEMISTRY OF SELECTED FLUORITE SHOWINGS

OLIVER SILICA SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F	CaF2
OS88-1	1.66	<0.01	0.08	0.08	<0.01	0.06	95.27	0.17	[illegible]	0.01	1.04	43.52	89.42
OS88-2	71.87	0.14	14.76	1.38	0.07	0.42	1.89	7.47	[illegible]	0.08	1.92	0.08	
OS88-3	50.91	0.38	27.98	5.92	0.16	0.91	0.30	0.88	[illegible]	0.24	3.76	0.70	

SAMPLE NO.	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
OS88-1	67	121	82						355	16	43		86		
OS88-2	668	15	44						20	14	38		231		
OS88-3	187	130	302						32	73	60		22		

WHITEMANCREEK SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F	CaF2
WM88-1A	2.31	<0.01	0.28	0.16	<0.01	0.08	88.82	0.21	0.08	0.02	0.02	48	88.63
WM88-1B	6.62	<0.01	0.63	0.24	<0.01	0.12	86.84	0.26	0.38	0.05	3.22	46.44	93.37
WM88-1C	3.16	<0.01	0.31	0.17	<0.01	0.09	88.36	0.21	0.09	0.04	1.33	47.87	88.36
WM88-1E	88.79	0.38	16.73	3.26	0.10	0.91	3.87	3.93	3.41	0.30	1.84	0.22	
WM88-1E2	88.75	0.36	16.60	3.26	0.10	0.88	3.75	3.91	3.44	0.27	1.83	0.20	

SAMPLE NO.	Au	Ag	As	Sb	Mo	Cu	Pb	Zn	Ni	Cr	Sn	Cs	Sc	Zr
WM88-1A	170	<5	<1.0	<0.2	8	18	10	15	2	<50	24	<1.0	<0.5	41
WM88-1B	31	<5	<1.0	<0.2	8	18	9	15	2	<50	20	<1.0	<0.5	55
WM88-1C	320	<5	<1.0	<0.2	8	15	9	13	2	<50	28	<1.0	<0.5	59
WM88-1E	<5	<5	<1.0	<0.2	8	27	23	70	2	<50	27	3.1	4.9	105
WM88-1E2	<5	<5	<1.0	<0.2	8	28	22	72	2	<50	23	2.3	5.3	116

SAMPLE NO.	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
WM88-1A	<100	11	34	5.9	2	3.2	12	1.9	166	<0.5	0.8	<10	400	7	<1.0
WM88-1B	<100	12	27	4.8	2	2.2	9	1.5	106	<0.5	<0.5	<10	410	26	<1.0
WM88-1C	<100	7	14	2.4	<2	<1.0	<5	0.6	63	<0.5	<0.5	<10	270	6	<1.0
WM88-1E	820	21	32	3.0	<2	<1.0	<5	<0.5	18	7.5	2.1	120	820	16	<1.0
WM88-1E2	720	19	42	3.0	<2	<1.0	<5	<0.5	14	6.8	1.6	120	765	24	<1.0

GALENA FARM SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F	CaF2
GF88-06	29.48	0.09	2.22	1.62	0.03	0.34	44.46	0.13	1.26	0.08	8.36	29.26	60.10
GF88-05	53.20	<0.01	0.56	2.65	0.26	1.18	11.21	0.13	0.10	0.11	6.15	8.13	16.71
GF88-07	32.20	<0.01	0.87	7.32	0.25	0.31	0.51	0.14	0.11	0.27	11.66	0.18	
GF88-08	67.40	0.21	3.59	10.53	0.88	1.21	0.45	0.15	1.23	0.18	8.26	0.02	
GF88-01	4.99	<0.01	0.49	0.47	0.01	0.10	65.72	0.18	0.07	0.11	2.60	46.08	94.68
GF88-10	39.82	0.01	0.93	30.76	3.71	2.18	0.90	0.12	0.09	0.04	19.61	0.10	
GF88-11	42.98	0.03	1.53	2.43	0.08	0.25	31.43	0.13	0.24	0.10	6.53	20.98	43.13
GF88-04	39.48	0.05	1.08	13.72	1.78	0.95	1.35	0.13	0.11	0.20	13.81	0.82	
GF88-02	37.29	<0.01	0.42	0.70	0.01	0.08	37.92	0.13	0.06	0.10	5.39	32.00	65.76

TABLE 20 CONT'D

SAMPLE NO.	Au	Ag	As	Sb	Mo	Cu	Pb	Zn	Ni	Cr	Sn	Ce	Sc	Zr	
GF88-06		11			83	16	485	680							
GF88-05		266			42	600	151000	53100							
GF88-07		1000			13	2600	40400	358000							
GF88-08		166			<8	146	40000	25800							
GF88-01		2			29	8	116	570							
GF88-10		10			<8	148	3500	10000							
GF88-11		36			28	720	14300	18500							
GF88-04		86			<8	240	2200	231000							
GF88-02		116			67	208	10800	21200							

SAMPLE NO.	Be	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
GF88-06	87	60	67						61	6			318		
GF88-05	34	15	15						X	X			X		
GF88-07	13	15	22						X	X			X		
GF88-08	72	15	22						X	X			X		
GF88-01	68	101	83						42	10			460		
GF88-10	34	30	48						11	6			27		
GF88-11	126	64	81						X	6			X		
GF88-04	27	11	41						10	6			19		
GF88-02	68	42	68						31	6			288		

REDBIRD SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F	CaF2		
SL88-2B	71.58	0.38	6.83	3.60	0.03	1.71	9.64	0.14	1.08	0.17	5.69	5.18	10.64		
SL88-3A	61.87	<0.01	0.82	0.22	<0.01	0.11	26.46	0.13	0.14	0.04	17.03	17.60	36.16		
SL88-4A	2.12	<0.01	0.32	0.13	<0.01	0.08	66.47	0.20	0.16	0.03	0.33	48.00	98.63		
SL88-4B	35.33	0.24	4.03	2.63	0.02	1.16	37.61	0.15	0.79	0.10	5.05	25.28	51.94		
SL88-4C	58.94	1.20	16.34	9.63	0.12	4.50	1.84	0.15	2.25	0.32	6.80	0.37			

SAMPLE NO.	Au	Ag	As	Sb	Mo	Cu	Pb	Zn	Ni	Cr	Sn	Ce	Sc	Zr	
SL88-2B	73	<6	7.1	12.0	76	21	12	46	12	62	23	15.0	10.0	77	
SL88-3A	30	<6	3.7	2.7	18	17	8	15	6	<50	25	3.8	0.7	53	
SL88-4A	6	<6	<1.0	<0.2	8	17	8	13	3	<50	24	<1.0	<0.6	49	
SL88-4B	280	<6	63.0	12.0	60	76	10	38	10	<50	26	9.3	6.1	71	
SL88-4C	8	<6	31.0	18.0	8	252	10	110	24	<50	23	22.0	22.0	110	

SAMPLE NO.	Be	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
SL88-2B	200	<6	<10	1.1	<2	<1.0	<6	<0.6	16	<0.6	<0.6	84	63	<6	<1.0
SL88-3A	180	6	<10	2.4	<2	<1.0	<6	<0.6	28	<0.6	<0.6	<10	126	26	<1.0
SL88-4A	<100	<6	10	1.1	<2	<1.0	<6	<0.6	16	<0.6	<0.6	<10	166	23	<1.0
SL88-4B	130	<6	<10	1.3	<2	<1.0	<6	<0.6	8	<0.6	<0.6	60	110	<6	<1.0
SL88-4C	660	6	<10	2.6	<2	<1.0	<6	<0.6	22	0.6	0.7	140	66	8	<1.0

Major element data in per cent, trace elements in parts per million except Au, which is in parts per billion. X=Interference noted due to high lead and zinc. Sample descriptions as follows: Oliver Silica - OS88-1 pale green to colourless fluorite; OS88-2 wallrock, granodiorite to quartz monzonite; OS88-3 biotite-rich phase of wallrock, adjacent to vein; Whiteman Creek - WM88-1A green, crystalline fluorite; WM88-1B green, massive fluorite; WM88-1C Purple, crystalline fluorite; WM88-1E host quartz monzonite; Galena Farm - GF88-06 pale purple to colourless fluorite-rich vein; GF88-05 quartz-fluorite-galena vein; GF88-07 sphalerite and galena rich-vein; GF88-08 altered host granite; GF88-01 pure pale purple to colourless fluorite; GF88-10 quartz-ankerite vein; GF88-11 galena-fluorite vein; GF88-04 sphalerite-rich vein; GF88-02 fluorite-rich vein; Redbird - SL88-2B chalcedonic quartz-fluorite vein; SL88-3A green and purple fluorite and chalcedonic quartz vein; SL88-4A pure purple fluorite; SL88-4B fluorite vein in altered volcanic rocks; SL88-4C weakly altered Nicola volcanics.

AREAS WITH MINOR OR TRACE FLUORSPAR ASSOCIATED WITH OTHER TYPES OF MINERALIZATION

Fluorite also occurs as a minor or trace constituent in a number of other deposit types including silver-lead-zinc veins, porphyry molybdenum-copper deposits, sedimentary phosphorites, niobium and rare-earth-element deposits in alkaline rocks and skarn and replacement deposits (Appendix 1). The fluorite may be present in trace amounts as microscopic grains, or locally comprise a few per cent of the rocks. The geochemical behavior of fluorine was examined in the Carmi molybdenum - Beaverdell silver-lead-zinc and Ainsworth silver-lead-zinc camps, in order to highlight and describe its potential as a pathfinder element. Fluorine has been used extensively as a pathfinder element in exploration for porphyry systems, and can equally well be used in the search for other commodities.

CARMI-BEAVERDELL AREA (82E/6 & 11)

The Carmi-Beaverdell area, south of Kelowna, is underlain by middle Jurassic granites, granodiorites and quartz monzonites of the Nelson suite and slightly younger Valhalla intrusions which have been emplaced in Paleozoic volcanic and sedimentary strata. In the immediate Beaverdell area, lead-zinc-silver veins, varying from a few centimetres to over a metre in width, are hosted by granitic rocks. The principal gangue minerals are quartz, calcite and, reportedly, minor fluorite (Kidd and Perry, 1957; White, 1950). West of the West Kettle River, numerous showings contain disseminated and fracture-controlled molybdenite and chalcopyrite mineralization with minor associated fluorite.

Rock samples collected from dumps at various showings and old mines in the Beaverdell camp, with one exception, did not contain any visible fluorspar. Analyses of between 100 and 600 ppm fluorine and up to 1.46 per cent silver, 0.77 per cent copper, 23.5 per cent lead, 7.75 per cent zinc and 1.8 per cent arsenic were obtained from various samples, some of which may have consituted ore. All vein material contained minimal amounts of strontium, yttrium, uranium and thorium (Table 21). Samples collected from altered and weakly mineralized outcrops associated with the porphyry molybdenum system west of the West Kettle River are slightly more enriched in fluorine, containing up to 1500 ppm, and have low base metal contents. Strontium contents, although low, are markedly higher than in the silver-lead-zinc vein material (Table 21).

Fluorine in water and silts from the Beaverdell area (Figure 22, Table 22, 23) does not highlight the areas of silver-lead-zinc mineralization, even though minor fluorite is associated with some veins in this camp. The statistical threshold for fluorine in waters is approximately 190 ppb in drainages underlain by granitic rocks in the areas surrounding Beaverdell. Only three samples collected in the vicinity of Beaverdell contain slightly over this threshold value. Primary indicators such as silver and arsenic in silts (Table 23) appear to be more useful than fluorine in this environment. Fluorine appears to be a slightly better pathfinder element for the porphyry molybdenum showings west of the West Kettle River, in particular in the vicinity of the Matt property, south of Beaverdell.

AINSWORTH AREA

The silver-lead-zinc ores of the Ainsworth camp occur in fissure veins and replacement deposits within limestones of the Lardeau and Milford groups, adjacent to the Nelson batholith. Fluorspar is reportedly one of the most common gangue minerals in the camp; it is abundant in the Early Bird and Silver Hoard mines, common at the Highland mine and locally present in vugs at the Number One and Kootenay Florence mines (Schofield, 1920; Wilson, 1929). Green, purple and pink varieties are locally present.

Rock samples were collected from various properties in the Ainsworth area. Samples from the Silver Hoard mine contain up to 3 per cent fluorine; those from the No. One and Highlander mines do not contain appreciable fluorine (Table 21). The samples all contain high concentrations of lead, zinc, silver and moderately high copper; trace elements such as strontium, yttrium, cerium, lanthanum and thorium are present in very low concentrations.

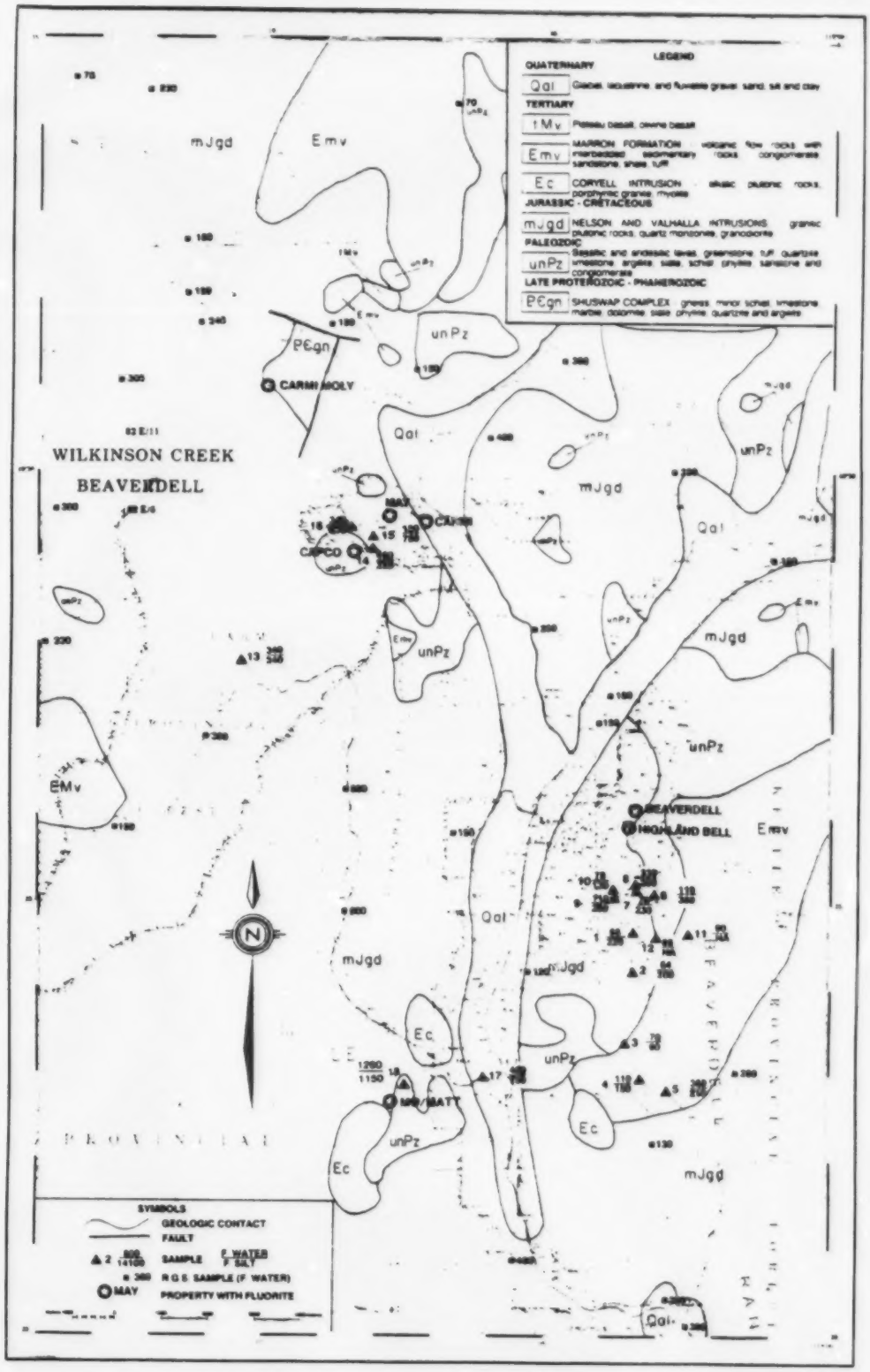


Figure 22. Fluorine-in-water and silts, Beaverdell-Carmi area.

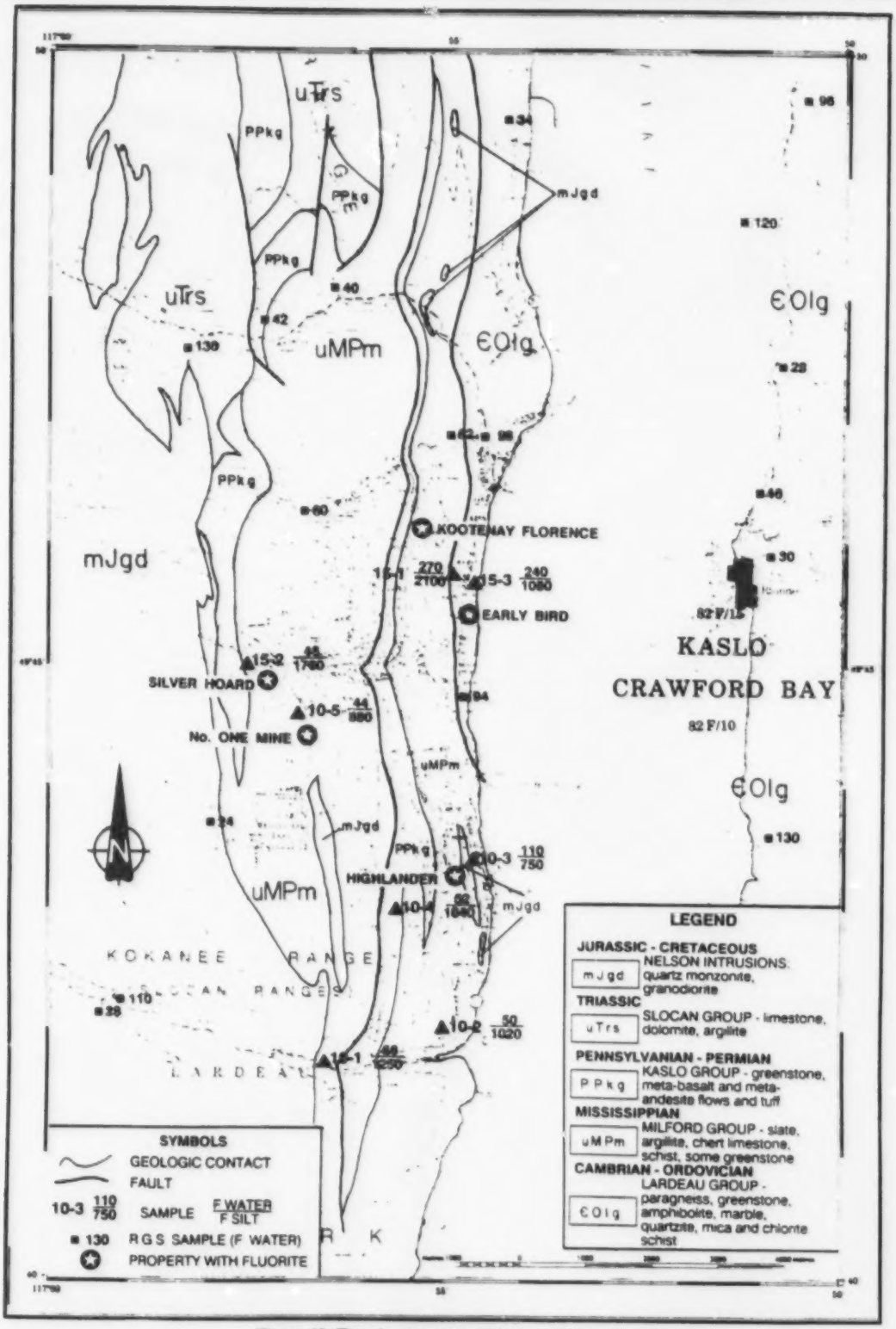


Figure 23. Fluorine-in-water and silts, Ainsworth area.

TABLE 21
ROCK GEOCHEMISTRY OF SELECTED SAMPLES FROM THE BEAVERDELL AND AINSWORTH AREAS

BEAVERDELL/CARMI SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F
BD88-14	69.44	0.45	14.11	4.86	1.20	0.63	0.88	0.15	3.83	0.26	4.66	550
BD88-13	68.90	0.36	15.41	2.03	0.02	0.36	0.73	3.18	7.00	0.20	0.84	1500
BD88-12A	67.86	0.20	16.34	2.66	0.03	0.66	0.30	1.26	8.23	0.14	1.36	830
BD88-12B	67.72	0.23	16.26	4.82	0.01	0.48	0.27	1.26	8.33	0.17	1.46	690
BD88-11	76.87	0.06	12.80	1.77	0.03	0.18	1.33	2.66	5.40	0.11	0.41	100
BD88-1A	78.82	0.10	4.00	5.01	0.18	0.48	1.62	0.16	1.13	0.26	4.34	180
BD88-1B	70.48	0.64	16.52	3.44	0.07	0.64	0.31	0.16	4.33	0.29	4.11	470
BD88-1C	61.11	0.04	1.80	4.58	0.04	0.23	1.06	0.16	0.52	0.28	8.87	140
BD88-1D	81.46	0.14	6.06	2.86	0.13	0.28	1.71	0.16	1.38	0.14	3.87	260
BD88-3A	76.78	0.07	2.74	3.86	0.78	0.64	1.86	0.16	0.83	0.28	4.82	120
BD88-3D	66.42	0.16	6.36	5.46	0.29	0.44	0.86	0.17	1.80	0.32	5.37	260
BD88-3E	66.84	0.12	3.84	10.13	2.48	0.48	1.06	0.16	0.88	0.24	7.84	150
BD88-6	62.36	0.78	16.21	4.88	0.08	2.60	3.81	3.26	4.16	0.63	3.03	920
BD88-4F	38.41	0.01	1.12	16.48	0.70	0.28	1.78	0.14	0.27	0.22	13.10	590
BD88-13	66.84	0.39	16.88	2.09	0.03	0.33	0.67	3.28	7.47	0.18	0.87	1300

SAMPLE	Ag	As	Sb	Mo	Cu	Pb	Zn	Ba	La	Ce	Y	Th	U	Sr
BD88-14	174	6800	60	<8	20	840	180	123	18	34	12	6	6	18
BD88-13	0.6	<50	<15	<8	52	11	39	1745	19	77	11	6	32	706
BD88-12A	<0.5	<50	<15	83	32	19	62	2611	15	78	10	6	37	667
BD88-12B	1	<50	<15	146	26	27	48	2468	33	78	10	6	23	626
BD88-11	1	<50	<15	<8	42	27	24	802	15	17	10	6	29	215
BD88-1A	3000	640	680	<8	2800	13600	23600	86	15	20	X	X	X	X
BD88-1B	32	280	181	<8	340	80	268	204	15	36	17	6	18	11
BD88-1C	3300	406	202	8	7700	236000	76700	38	15	15	X	X	X	X
BD88-1D	1200	280	64	<8	660	14200	17800	91	15	15	X	X	X	X
BD88-3A	700	6300	153	8	260	7400	66000	47	15	21	X	X	X	X
BD88-3D	6700	12400	1700	<8	870	57700	53300	86	15	15	X	X	X	X
BD88-3E	2700	18400	646	<8	660	16200	17600	38	15	29	X	X	X	X
BD88-6	8	<50	<15	<8	11	111	149	2136	69	186	26	21	33	1148
BD88-4F	14600	1200	1300	<8	2200	180000	77600	13	15	15	X	X	X	X
BD88-13	0.8	<50	<15	<8	57	14	50	1771	21	78	11	15	25	711

AINSWORTH SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F
AI88-2B	23.23	<0.01	0.38	7.39	1.88	5.62	21.20	0.11	0.06	0.07	19.86	15000
AI88-2C	12.62	<0.01	0.26	7.45	2.62	5.49	22.84	0.10	1.20	0.10	14.49	3
AI88-3A	60.66	0.02	1.16	7.78	2.36	3.58	12.80	0.11	1.07	0.07	12.98	380
AI88-3B	67.96	<0.01	0.67	2.13	0.27	1.10	3.22	0.12	1.07	0.30	8.23	300
AI88-1B	4.39	0.06	1.80	16.76	2.00	2.43	19.18	0.12	0.12	0.07	14.30	160
AI88-1C	24.26	0.10	1.36	21.68	4.98	1.63	10.88	0.12	0.27	0.08	21.82	300
AI88-2A	26.74	0.02	1.23	10.17	0.30	2.14	16.86	4.33	0.32	0.12	8.42	130

SAMPLE NO.	Ag	As	Sb	Mo	Cu	Pb	Zn	Ba	La	Ce	Y	Th	U	Sr
AI88-2B	480			<8	380	101000	13000	27	26	43	X	X	X	
AI88-2C	3100			<8	2600	21400	124000	33	35	64	X	6	X	
AI88-3A	180			<8	64	4400	13600	39	23	48	13	6	499	
AI88-3B	48			<8	102	26	144000	33	15	23	10	6	67	
AI88-1B	120			<8	1700	164000	62600	19	15	43	X	X	X	
AI88-1C	23			<8	1300	910	66400	64	34	64	10	14	127	
AI88-2A	2600			<8	1200	81600	244000	24	15	42	X	X	X	

Major element data is in per cent, fluorine and trace elements in parts per million. X = Interference noted due to high lead and zinc. Sample descriptions as follows: Beaverdell/Carmi Area - BD88-14 quartz-fluorite vein in altered granite, Highland Bell mine; BD88-13 disseminated purple fluorite in altered granodiorite, Matt property; BD88-12A altered granodiorite with minor fluorite, Matt property; BD88-12B altered granodiorite with specularite, Matt property; BD88-11 quartz vein, Carmi Moly property; BD88-1A quartz vein with galena, pyrite and chalcopyrite, Wallace Mountain; BD88-1B altered granite, Wallace Mountain; BD88-1C galena-rich vein, Wallace Mountain; BD88-1D altered granite with quartz veins, Wallace Mountain; BD88-3A sphalerite-rich vein, Bounty claim; BD88-3D galena-rich vein, Bounty claim; BD88-3E silicified granite and vein quartz with sphalerite, galena and pyrite, Bounty claim; BD88-6 andesite, Goat Peak; BD88-4F sphalerite and galena-rich vein, Bounty Fraction; Ainsworth area - AI88-2B galena-sphalerite-pyrite replacement mineralization in marble, Silver Hoard mine; AI88-2C silicified marble with galena and sphalerite, Silver Hoard mine; AI88-3A mineralized, silicified limestone, No. One mine; AI88-3B sphalerite replacement mineralization in limestone, No. One mine; AI88-1B galena-pyrite-ankerite-calcite vein, Highlander mine; AI88-1C marcasite-sphalerite-ankerite-calcite vein, Highlander mine; AI88-2A sphalerite and galena in limestone breccia, Silver Hoard mine.

TABLE 22
STREAM-WATER CHEMISTRY,
BEAVERDELL/CARMI AREA

SAMPLE NO.	U ppb	F ppb	pH
82E/6-1	1.4	66	8.1
82E/6-2	2.9	64	7.6
82E/6-3	4.1	70	7.9
82E/6-4	2.2	110	7.9
82E/6-5	0.06	360	7.7
82E/6-6	0.47	110	7.9
82E/6-7	1.3	76	7.9
82E/6-8	65.0	330	8.0
82E/6-9	1.2	110	7.8
82E/6-10	2.3	78	7.9
82E/6-11	0.02	90	6.8
82E/6-12	1.0	66	8.2
82E/6-13	0.38	340	7.5
82E/6-14	2.8	160	8.4
82E/6-15	3.6	150	8.0
82E/6-16	0.57	340	7.7
82E/6-17	0.52	460	7.2
82E/6-18	0.35	1200	7.2

TABLE 23
STREAM-SEDIMENT GEOCHEMISTRY, BEAVERDELL/CARMI AREA

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb
82E/6 S1	1	37	18	84	0.4	5	8	539	2.98	19	5	0	4	83	1	2
82E/6 S2	2	57	22	121	1	7	9	815	3.89	4	5	0	5	43	1	2
82E/6 S3	1	44	14	72	1.3	5	5	334	1.77	2	13	1	2	42	1	2
82E/6 S4	1	58	19	120	1.7	8	8	419	2.75	5	5	0	6	42	1	2
82E/6 S5	1	18	4	44	0.1	8	7	281	2.98	2	5	0	8	33	1	2
82E/6 S6	1	60	36	116	0.3	11	11	669	2.98	29	5	0	3	69	1	3
82E/6 S7	1	39	19	101	0.3	9	8	415	2.09	19	5	0	1	50	1	2
82E/6 S8	1	40	69	287	1.8	7	9	924	2.19	38	5	0	7	72	3	2
82E/6 S9	1	27	57	272	13.3	10	7	600	3.42	27	5	0	15	42	1	3
82E/6 S10	1	74	47	274	3	8	6	1009	2.25	34	5	0	2	70	2	2
82E/6 S13	1	12	3	41	0.1	3	5	313	1.90	2	5	0	10	35	1	2
82E/6 S14	1	38	11	88	0.1	7	7	419	2.73	2	5	0	2	52	1	2
82E/6 M14	1	51	2	86	0.1	7	7	488	2.84	2	5	1	1	85	1	2
82E/6 S15	1	45	12	89	0.1	8	11	758	3.45	2	5	0	4	81	1	2
82E/6 S16	1	24	4	53	0.1	9	6	322	1.84	2	5	1	3	38	1	2
82E/6 S17	1	10	7	133	0.1	7	5	222	2.53	2	5	0	6	79	1	2
82E/6 S18	10	393	37	2930	0.1	11	8	449	2.17	2	29	0	1	276	2	2

SAMPLE NO.	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
82E/6 S1	2	61	1.24	.071	17	11	0.59	142	0.04	2	1.87	0.01	0.10	1	220
82E/6 S2	2	72	0.66	.045	21	13	0.53	151	0.05	3	2.24	0.01	0.09	1	200
82E/6 S3	2	30	0.87	.039	18	8	0.27	95	0.04	2	1.63	0.01	0.05	1	60
82E/6 S4	2	47	0.61	.042	57	10	0.34	98	0.05	2	2.34	0.01	0.08	1	150
82E/6 S5	2	59	0.32	.088	19	9	0.38	78	0.03	2	0.73	0.01	0.06	1	210
82E/6 S6	2	59	0.84	.071	14	13	0.63	77	0.06	2	1.88	0.02	0.15	1	380
82E/6 S7	2	41	1.08	.047	10	10	0.43	88	0.03	3	1.14	0.01	0.07	1	230
82E/6 S8	2	35	1.47	.080	15	7	0.49	142	0.03	2	0.89	0.01	0.05	1	300
82E/6 S9	2	63	0.80	.074	15	12	0.44	122	0.03	2	1.09	0.01	0.07	1	260
82E/6 S10	2	35	1.58	.064	19	8	0.35	151	0.03	5	1.70	0.01	0.08	1	130
82E/6 S13	2	34	0.60	.081	27	8	0.24	48	0.05	2	0.76	0.01	0.07	1	240
82E/6 S14	2	53	1.03	.087	12	9	0.47	64	0.05	2	0.98	0.01	0.18	1	220
82E/6 M14	2	52	1.80	.086	12	10	0.48	81	0.04	6	1.07	0.02	0.19	1	300
82E/6 S15	2	63	1.48	.092	14	11	0.77	74	0.05	2	1.48	0.01	0.24	1	780
82E/6 S16	2	29	0.59	.072	15	12	0.41	48	0.05	5	0.97	0.01	0.10	1	530
82E/6 S17	2	45	0.59	.102	50	14	0.29	98	0.05	2	0.95	0.01	0.08	1	750
82E/6 S18	2	20	1.10	.045	209	6	0.20	155	0.04	3	3.22	0.02	0.11	1	1150

TABLE 24
STREAM-WATER CHEMISTRY,
AINSWORTH AREA

SAMPLE NO.	U ppb	F ppb	pH
82F/10-1	0.22	66	7.9
82F/10-2	0.35	50	8.0
82F/10-3	1.4	110	7.9
82F/10-4	0.18	52	7.9
82F/10-5	0.26	44	7.8
82F/15-1	0.36	270	8.5
82F/15-2	0.61	46	8.3
82F/15-3	0.35	240	8.3

TABLE 25
STREAM-SEDIMENT GEOCHEMISTRY, AINSWORTH AREA (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb
82F/10 S1	1	9	7	67	0.3	18	7	248	2.15	3	5	0	6	96	1	3
82F/10 M1	1	11	22	57	0.1	14	6	234	1.86	2	5	0	6	99	1	2
82F/10 S2	1	34	303	662	1.8	41	15	951	3.29	12	5	0	5	44	3	2
82F/10 M2	1	44	374	770	2.6	49	15	1224	3.68	13	5	0	3	54	5	2
82F/10 S3	1	42	55	451	0.2	48	14	473	3.31	4	5	0	5	39	1	2
82F/10 S4	1	30	37	170	0.4	40	13	637	2.98	9	5	0	4	38	1	2
82F/10 S5	1	33	21	102	0.7	42	17	681	4.27	10	5	0	8	62	1	2
82F/10 M5	1	32	24	117	0.4	37	15	833	3.86	8	5	1	8	170	1	2
82F/15 S1	1	55	1288	1514	2.1	23	9	1053	2.82	71	5	0	4	136	7	2
82F/15 S2	1	37	45	131	0.3	40	12	789	3.18	7	5	0	3	45	1	2
82F/15 S3	1	60	950	1773	1.3	33	13	1188	3.62	38	5	1	4	108	7	2

S denotes stream sediment, M denotes moss-mat sample

SAMPLE NO.	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
82F/10 S1	2	27	1.57	0.131	24	22	0.46	27	0.04	2	0.65	0.01	0.08	1	1250
82F/10 M1	2	24	1.71	0.129	25	20	0.46	30	0.03	2	0.60	0.01	0.08	2	910
82F/10 S2	2	44	0.73	0.116	23	47	0.98	79	0.05	3	1.59	0.01	0.11	1	1020
82F/10 M2	2	48	0.88	0.130	25	54	1.06	92	0.05	2	1.77	0.01	0.14	1	900
82F/10 S3	2	58	0.38	0.054	10	47	1.27	108	0.17	2	2.63	0.02	0.62	1	750
82F/10 S4	2	42	0.44	0.089	21	44	0.89	65	0.04	2	1.47	0.01	0.10	1	1040
82F/10 S5	2	58	0.79	0.114	31	48	0.93	59	0.04	2	1.28	0.01	0.11	1	880
82F/10 M5	3	50	1.07	0.139	32	46	1.15	55	0.05	2	1.47	0.01	0.13	1	790
82F/15 S1	2	28	3.13	0.067	12	22	0.63	49	0.08	2	1.13	0.01	0.28	1	2120
82F/15 S2	2	43	1.17	0.092	29	49	0.87	58	0.05	3	1.51	0.01	0.15	1	1080
82F/15 S3	2	40	2.21	0.060	17	37	1.00	85	0.09	2	1.92	0.02	0.38	1	1700

S denotes stream sediment, M denotes moss-mat sample

TABLE 26
ROCK GEOCHEMISTRY, KECHIKA YTTRIUM AND RARE-EARTH PROSPECT

SAMPLE NO.	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	LOI	F
RE88/9A	46.30	1.18	17.58	7.14	0.26	3.92	11.65	3.48	4.48	0.36	2.78	6200
RE88/9C	49.38	0.82	17.25	6.33	0.23	3.26	9.55	3.24	4.92	0.26	2.96	3200
RE88/9E	64.46	0.52	16.58	4.70	0.17	1.41	6.17	3.09	6.28	0.14	2.66	15000
RE88/11A	30.23	0.58	9.67	6.38	0.21	7.19	16.01	0.23	6.40	0.12	20.86	10000
RE88/11C	29.48	0.51	8.65	7.17	0.18	7.24	16.26	0.15	6.43	0.16	18.58	7600
RE88/12A	29.86	0.02	7.92	6.40	0.23	7.60	14.12	0.15	6.60	0.04	20.88	460
RE88/12B	58.36	0.04	7.44	4.01	0.26	3.88	8.40	0.21	5.32	0.03	11.86	700
RE88/12C	16.26	0.38	3.09	7.81	0.42	10.11	24.34	1.20	0.76	0.23	32.63	720
RE88/16A	19.46	0.05	3.92	8.99	0.30	10.00	20.86	0.11	3.11	0.02	30.97	140
RE88/17A	41.86	0.08	8.54	2.14	0.06	0.43	20.71	0.14	3.46	18.30	1.82	12600
RE88/18B	33.34	1.18	6.07	9.78	0.14	13.65	9.55	0.06	4.80	0.24	16.97	18000
RE88/23C	28.66	0.12	0.90	6.58	0.38	11.30	18.89	0.18	0.28	0.03	30.83	1460
RE88/25	13.03	0.01	0.45	2.93	0.11	16.87	26.62	0.13	0.13	0.06	37.44	830
RE88/28B	8.57	0.30	2.90	28.29	0.14	6.92	13.25	0.11	1.06	0.14	26.86	9700
RE88/38D	26.20	0.91	7.48	6.25	0.37	8.29	18.23	0.26	5.96	0.19	21.53	18000
RE88/38F	35.68	0.86	10.35	5.96	0.28	8.45	12.56	2.10	7.74	0.26	14.78	19000
RE88/38G	37.04	1.12	10.42	7.13	0.38	10.68	9.89	2.74	6.04	0.21	13.05	18000
RE88/53A	88.15	0.30	16.40	3.06	0.06	0.64	2.03	0.13	7.48	0.09	3.56	2400
RE88/54	70.88	0.11	13.88	2.16	0.04	0.94	2.39	0.24	8.16	0.02	2.96	2900
RE88/57A	1.00	<0.01	0.23	0.16	<0.01	0.04	69.89	0.11	0.06	0.03	0.73	48.32%
RE88/57B	37.59	0.76	16.54	8.37	0.29	3.06	17.85	2.69	2.85	0.26	7.73	12600
RE88/57D	40.12	1.39	13.78	8.00	0.23	7.23	13.17	2.88	4.34	0.33	8.02	7000
RE88/60	9.51	0.59	0.82	4.11	0.66	3.74	48.64	0.13	0.63	0.04	14.11	24.83%
RE88/60B	3.09	0.66	0.58	5.83	1.20	1.72	50.90	0.14	0.20	0.03	22.71	18.24%
RE88/75	45.86	2.30	14.01	5.79	0.16	3.09	6.86	0.28	10.36	0.47	9.31	800
RE88/82A	38.30	1.85	10.53	7.58	0.16	3.90	10.42	0.25	9.07	0.01	14.93	220
A88K48	37.02	0.06	9.11	2.04	0.07	2.16	22.02	0.16	3.18	13.70	6.38	11500
1734	38.76	0.95	10.07	6.92	0.48	10.01	11.27	2.86	4.20	0.21	14.22	14500
1655	1.82	0.02	0.76	5.16	0.33	16.67	29.83	0.11	0.31	0.06	43.18	320
1656	38.38	1.80	10.83	4.69	0.13	4.76	12.78	0.37	8.82	2.42	14.20	2900
1687	46.86	0.08	7.52	5.28	0.17	4.73	10.90	0.20	6.52	0.02	16.93	320
1688	47.52	1.06	18.45	8.59	0.16	3.27	6.97	6.76	6.86	0.28	3.23	3100
1266	43.38	0.78	19.42	4.67	0.14	1.22	9.07	0.90	9.08	0.16	9.13	5300
1671	72.17	0.68	14.67	1.63	0.01	1.03	1.10	0.17	5.06	0.34	2.36	1800
1664	72.47	0.15	11.06	3.96	0.01	0.32	0.86	0.24	8.48	0.07	2.14	820
1677	42.28	0.62	11.86	2.83	0.07	2.43	17.28	3.08	5.74	0.18	12.02	9800
1658	9.57	0.06	0.84	9.81	0.64	11.28	26.44	0.13	0.28	0.08	38.71	170
1660	36.08	0.06	6.16	2.83	0.08	2.47	24.60	0.26	1.66	18.20	7.15	12700
1731	87.28	0.45	14.86	2.22	0.04	0.36	1.76	0.41	10.90	0.15	2.00	320
1738	19.82	0.81	5.38	7.47	0.44	9.37	20.21	0.25	4.02	1.31	28.47	2660
1690	34.36	1.14	8.32	9.48	0.12	16.11	5.44	2.13	1.71	0.19	23.31	1800
1697	22.82	0.21	5.38	1.80	0.08	1.82	36.83	1.33	2.43	0.13	26.39	1000
1733	41.46	0.74	8.87	6.81	0.26	5.11	21.70	0.72	3.76	0.18	15.88	3700
1656	25.88	0.07	5.53	4.83	0.26	6.20	20.57	0.26	3.86	8.30	18.66	6200
1729	65.84	0.49	17.52	1.68	0.01	0.67	0.87	0.85	10.80	0.11	1.72	760
1681	61.06	0.46	18.86	2.39	0.06	0.42	6.70	5.48	8.19	0.18	5.18	16000
1695	56.02	0.08	9.63	1.95	0.06	4.80	7.86	0.24	7.28	0.06	12.63	460
1676	49.49	0.88	19.87	8.66	0.20	1.74	5.18	8.14	8.33	0.28	1.84	4700
1673	38.70	1.65	13.72	9.63	0.43	8.01	9.37	2.68	5.28	0.44	8.17	7600
1687-D	47.48	0.08	8.30	5.13	0.17	4.72	10.20	0.26	6.45	0.03	16.78	370

TABLE 26 CONT'D.

SAMPLE NO.	Au	Ag	As	Sb	Mo	Cu	Pb	Zn	Co	Ni	Cr	Sn	W	Ce	Sc	Zr	Bi	V
RE88/9A	<5	<5	40.0	0.8	3	-	20	137	-	76	150	29	-	7.7	8.6	120	-	-
RE88/9C	<5	<5	30.0	0.7	<2	-	11	169	-	<20	<50	21	-	4.8	3.7	120	-	-
RE88/9E	<5	<5	27.0	1.7	17	-	16	117	-	<20	<50	26	-	2.4	3.3	416	-	-
RE88/11A	<5	<5	10.0	1.5	3	-	11	16	-	29	60	23	-	<1.0	8.4	83	-	-
RE88/11C	<5	<5	12.0	0.1	4	-	16	13	-	<20	<50	25	-	<1.0	4.3	76	-	-
RE88/12A	<5	<5	1.9	1	4	-	10	12	-	<20	110	13	-	<1.0	2.7	89	-	-
RE88/12B	<13	<5	18.0	<.2	<8	-	508	12	-	<89	340	29	-	<1.0	3.6	93	-	-
RE88/12C	<15	<12	16.0	<.2	<7	-	27	27	-	<88	280	23	-	<2.2	8.8	75	-	-
RE88/16A	<5	<5	8.1	.7	4	-	3	26	-	<20	<50	20	-	<1.0	1.7	68	-	-
RE88/17A	<180	<5	<90.0	1.6	<56	-	28	8	-	<98	<440	31	-	<1.0	8.8	<9	-	-
RE88/18B	<5	<5	17.0	3	<2	-	8	231	-	600	1100	22	-	3.1	18	105	-	-
RE88/23C	17	<5	12.0	1.8	<8	-	12	263	-	<58	<50	23	-	<1.0	5	59	-	-
RE88/26	<5	<5	3.4	0.8	<2	-	8	8	-	<20	<50	26	-	<1.0	0.8	61	-	-
RE88/28B	24	<5	24.0	1.3	7	-	20	13	-	<45	84	28	-	<1.0	3.8	70	-	-
RE88/38D	<5	<5	82.0	3.8	16	-	1000	1300	-	64	450	31	-	<1.0	8.7	95	-	-
RE88/38F	<5	<5	48.0	2.7	130	-	750	1000	-	210	510	27	-	3.8	12	225	-	-
RE88/38G	<5	<5	31.0	2.3	221	-	68	400	-	270	720	26	-	8	8	440	-	-
RE88/53A	<5	<5	<1.0	0.5	2	-	7	5	-	<20	<50	36	-	<1.0	2.2	470	-	-
RE88/54	<5	<5	6.5	0.8	<2	-	20	4	-	<20	<50	41	-	2.1	0.7	326	-	-
RE88/57A	<5	<5	<1.0	<.2	<2	-	6	4	-	<20	<50	17	-	<1.0	<.5	48	-	-
RE88/57B	<5	<5	22.0	0.8	2	-	10	278	-	68	<50	28	-	4.4	7.8	<5	-	-
RE88/57D	<5	<5	12.0	1.1	8	-	160	174	-	180	360	37	-	7	16	140	-	-
RE88/60	280	<13	2000.0	11.0	120	-	40	28	-	<89	280	23	-	<2.4	5.8	53	-	-
RE88/60B	140	<16	466.0	2.4	25	-	110	73	-	<110	380	29	-	<2.8	4	32	-	-
RE88/75	<5	<5	18.0	1.5	<2	-	20	7	-	25	<50	19	-	<1.0	17	180	-	-
RE88/82A	<5	<5	8.0	2.2	3	-	10	28	-	29	<50	30	-	<1.0	11	130	-	-
A88K48	89	<5	86.0	1.6	58	-	24	7	-	43	340	30	-	<1.0	5.7	<8	-	-
1734	-	-	-	-	43	79	425	47	269	688	-	-	26	16	18.5	181	22	132
1665	-	-	-	-	22	6	36	66	3	6	10	6	21	30	29.4	41	25	34
1666	-	-	-	-	12	17	26	26	42	40	82	<3	77	2	17	169	29	166
1667	-	-	-	-	20	11	21	27	16	7	22	<3	106	13	10.2	86	26	121
1669	-	-	-	-	16	41	32	137	35	68	100	<4	61	11	10.7	270	33	122
1265	-	-	-	-	24	21	21	230	12	7	10	<4	40	8	7.8	267	33	61
1671	-	-	-	-	53	10	23	19	7	18	75	21	118	<10.0	<.2	528	40	72
1664	-	-	-	-	90	26	21	21	36	30	11	9	232	4	<.5	122	34	49
1677	-	-	-	-	41	10	38	76	10	8	66	6	53	11	18.2	235	39	74
1668	-	-	-	-	21	5	41	66	11	8	45	5	72	25	27.1	26	29	213
1660	-	-	-	-	<3	122	46	32	84	66	20	4	186	20	28.7	190	26	47
1731	-	-	-	-	14	18	27	21	18	18	13	<4	87	5	0.2	367	30	14
1739	-	-	-	-	7	16	26	64	27	78	328	<4	66	16	31.9	56	21	370
1690	-	-	-	-	24	18	22	63	82	614	1100	<4	4	0	18.5	108	31	161
1687	-	-	-	-	36	4	66	82	3	6	20	6	33	27	34.1	164	43	37
1733	-	-	-	-	100	83	56	66	60	182	661	<5	84	5	22.2	176	56	149
1656	-	-	-	-	<3	14	44	22	31	22	17	<4	66	20	22.9	100	18	69
1729	-	-	-	-	16	8	11	21	7	6	16	9	47	4	<.7	886	22	6
1661	-	-	-	-	<3	14	20	66	18	11	12	<4	69	7	6.1	169	20	27
1695	-	-	-	-	17	16	16	20	11	6	28	5	80	11	6.9	169	35	84
1676	-	-	-	-	8	23	31	172	24	18	18	<4	37	12	6.5	380	35	112
1673	-	-	-	-	83	41	27	243	39	168	364	11	31	12	22.8	143	18	238
1667-D	-	-	-	-	18	5	9	26	8	3	21	6	48	13	10.8	76	26	117

TABLE 26 CONT'D.

SAMPLE NO.	Ba	La	Ce	Sm	Eu	Tb	Yb	Lu	Y	Th	U	Rb	Sr	Nb	Ta
RE88/9A	1600	100	170	7.7	<2	1.7	<6	<.6	<6	22	3.6	270	1600	130	11
RE88/9C	1800	130	200	7.6	<2	1.1	<6	<.6	<6	31	5.4	230	2800	140	10
RE88/9E	2000	120	210	10	<2	<1.0	<6	<.6	24	64.2	17	220	1500	405	7.8
RE88/11A	2000	41	69	4	<2	<1.0	<6	<.6	<6	16	0.8	160	660	85	3.5
RE88/11C	1500	63	95	8.2	<2	1.3	<6	<.6	8	56.6	1.8	160	570	62	3.4
RE88/12A	30700	120	240	41.8	4	3.6	<6	<.6	47	269	1.4	160	400	43	<1.0
RE88/12B	<210	640	860	112	17	8.4	7	1	68	583	2.3	100	150	74	<1.0
RE88/12C	1600	875	1020	108	21	10	<22	<1.0	103	748	2.2	<48	505	130	2.2
RE88/16A	310	60	110	11	2	1.1	<6	<.6	20	55.4	<0.6	69	275	37	1.1
RE88/17A	1700	360	690	438.0	170	200.0	<230	18.0	4400	2820.0	<33.0	95	430	130	2.4
RE88/18B	870	15	33	3.4	<2	<1.0	<6	<.6	32	3	<0.6	380	295	8	1.2
RE88/23C	3900	360	320	116	34	14	<21	1.6	120	620	4.8	<31	610	195	<1.0
RE88/25	<100	<6	<10	0.7	<2	<1.0	<6	<.6	6	3.1	<0.6	<10	140	18	<1.0
RE88/28B	<100	480	610	16	<4	1.3	<6	<.6	35	64.9	<0.6	27	185	23	<1.0
RE88/38D	600	450	630	46.6	8	4.2	8	0.7	37	316	3.7	130	815	30	2.6
RE88/38F	600	440	560	8.5	<4	<1.0	<6	<.6	32	15	2.4	230	790	20	3.9
RE88/38G	430	360	440	10	<2	1.8	<6	<.6	55	16	7.5	320	810	<6	4.2
RE88/53A	270	130	270	14	<2	1.8	8	<.6	62	36	6.5	180	71	94	10
RE88/54	230	71	140	8.4	<2	1.5	6	<.6	63	57.3	10	170	65	270	17
RE88/57A	<100	<6	<10	<.2	<2	<1.0	<6	<.6	<6	<0.6	<0.6	<10	405	9	<1.0
RE88/57B	580	120	210	10	2	1.1	<6	<.6	<6	13	7.1	210	3500	83	5.2
RE88/57D	3100	77	130	7.6	3	<1.0	<6	<.6	20	14	2.4	220	1100	81	8.2
RE88/60	<300	1120	1050	47.8	<9	5.8	<37	3.3	460	778	1.4	<53	1100	125	<1.0
RE88/60B	<310	1870	1870	69.7	<13	7	<30	2.4	340	972	<1.3	<66	1300	130	<2.2
RE88/75	5200	20	48	5.4	2	1	<6	<.6	21	7.4	1	83	150	34	3.8
RE88/82A	130	23	54	3.1	<2	<1.0	<6	<.6	9	11	0.7	220	140	60	3.7
AB8K48	310	250	440	308.0	130	173.0	<120	20.0	4300	2380.0	37.0	88	400	120	1.7
1734	412	188	270	-	-		8	-	50	29	35	314	708	92	8
1665	110	88	117	-	-	-	<4	-	24	53	44	56	1243	23	5
1666	377	49	86	-	-	-	48	-	770	208	61	166	376	104	10
1669	1245	120	183	-	-	-	8	-	41	46	46	316	2153	184	11
1266	4059	89	170	-	-	-	8	-	33	35	34	278	1593	303	19
1671	405	15	15	-	-	-	11	-	40	58	61	144	50	85	10
1664	618	19	60	-	-	-	11	-	19	22	28	164	42	63	12
1677	863	85	127	-	-	-	<6	-	38	49	50	252	1682	66	6
1668	713	478	628	-	-	-	<4	-	61	226	48	43	467	38	5
1660	1866	222	643	-	-	-	227	-	6871	3312	98	38	624	43	60
1731	678	33	83	-	-	-	11	-	38	19	25	83	58	138	15
1738	417	317	423	-	-	-	23	-	386	322	46	106	886	438	5
1680	178	28	36	-	-	-	<3	-	23	32	42	95	212	60	6
1667	345	83	112	-	-	-	<4	-	28	63	63	88	883	47	6
1733	174	341	510	-	-	-	6	-	46	6	28	127	420	80	6
1656	622	61	106	-	-	-	167	-	2645	1322	101	86	686	32	22
1728	188	101	208	-	-	-	11	-	80	46	34	176	42	273	21
1661	1881	71	128	-	-	-	8	-	27	36	52	248	5534	141	12
1686	3058	71	162	-	-	-	3	-	44	138	36	137	108	66	6
1676	1849	134	174	-	-	-	6	-	31	37	41	316	2188	241	10
1673	1720	342	613	-	-	-	6	-	62	283	40	286	2438	272	6
1667-D	847	64	114	-	-	-	0	-	18	63	30	124	160	38	6

TABLE 26 CONT'D

Major element data is in per cent, fluorine in parts per million except where indicated and trace elements in parts per million except Au, which is in parts per billion. Sample descriptions as follows RE88-9A Mafic syenite with feldspar phenocrysts; RE89-9C medium-grained leucosyenite with a trace of disseminated fluorite; leucosyenite with abundant fluorite; RE88-11A orange-weathering, rounded-pebble breccia with fluorite; RE88-11C Orange weathering, rounded-pebble breccia with fluorite and pyrite; RE88-12A massive quartz-feldspar-carbonate-sericite rock; RE88-12B foliated quartz-feldspar-carbonate-sericite rock; RE88-12C red-brown-weathering carbonatite dike; RE88-16A red-brown-weathering carbonatite dike; RE88-17A quartz-carbonate-sericite-apatite rock; RE88-18B strongly foliated mafic dike with chrome mica and chlorite spots; RE88-23C silicocarbonatite dike with trace fluorite: RE88-25 white-weathering quartz-carbonate aplite; RE88-28B breccia along the margin of an aplite dike consisting of angular dolomite fragments in a matrix of pyrite and minor fluorite; RE88-38D carbonate-fluorite veins crosscutting a diatreme breccia; RE88-38F diatreme breccia with fluorite veins; RE88-38G typical diatreme breccia; RE88-53A grey-weathering vescicular mafic dike; RE88-54 white-weathering aplite; RE88-57A pure purple fluorite from vein in mafic syenite; RE88-57B calcite-biotite-epidote-fluorite vein in mafic syenite; RE88-57D mafic syenite; RE88-60 biotite-fluorite-pyrite vein; RE88-60B biotite-fluorite-pyrite vein; RE88-75 vescicular mafic dike; RE88-82A agglomerate/tuff; A88K48 quartz-feldspar-carbonate-sericite-apatite rock; 1734 crystal and lithic fragment breccia; 1655 carbonatite; 1555 quartz-feldspar-carbonate-sericite-apatite rock; 1687 quartz-feldspar carbonate-sericite rock; 1699 mafic syenite; 1265 leucosyenite; 1671 quartz-feldspar-sericite rock; 1664 quartz-feldspar-sericite rock; 1677 breccia; 1658 carbonatite; 1660 quartz-feldspar-apatite-sericite rock; 1731 sheared leucosyenite; 1739 Tuff breccia; 1690 Green to orange weathering tuff breccia; 1697 quartz-feldspar-carbonate-sericite rock; 1733 green to orange-weathering tuff breccia; 1656 carbonatite; 1729 quartz-feldspar-sericite-carbonate rock; 1681 leucosyenite; 1695 quartz-feldspar-carbonate-sericite rock: 1676 mafic syenite; 1673 biotite-rich mafic syenite; 1687-D duplicate of 1687.

TABLE 27
STREAM WATER CHEMISTRY, KECHIKA AREA

SAMPLE NO.	U ppb	F ppb	pH
94L/11-1	1.1	300	8.2
94L/11-2	0.81	24	8.2
94L/11-3	1.4	220	8.2
94L/11-4	1.2	220	8.2
94L/11-5	6.6	10	8.2
94L/11-6	1.3	410	8.1
94L/11-7	1.1	220	8.4
94L/11-8	2.9	10	8.4
94L/11-9	2.0	20	8.3
94L/11-10	2.1	10	8.3
94L/11-11	4.4	22	8.5
94L/11-12	2.1	540	8.3
94L/11-13	1.4	230	8.3
94L/11-14	3.4	300	8.3
94L/11-15	1.4	260	8.3
94L/12-1	1.1	360	8.2
94L/12-2	1.1	190	8.1
94L/12-3	1.7	86	8.1
94L/12-4	2.3	10	8.4
94L/12-5	4.1	32	8.3
94L/12-6	1.6	44	8.3
94L/12-7	3.4	130	8.5
94L/12-8	2.0	260	8.2
94L/12-9	3.0	10	8.2
94L/12-10	3.7	48	8.2
94L/12-11	0.75	130	8.1
94L/12-12	1.4	350	8.2
94L/12-13	1.1	110	8.2

Fluorine in waters and silts from creeks in the Ainsworth area does not correlate well with deposits which are known to contain fluorspar (Figure 23, Tables 24, 25). Anomalous populations for drainages underlain by quartzites contain in excess of 80 ppb fluorine in waters; areas underlain by schists and argillites, and containing in excess of 115 ppb fluorine in waters, may be anomalous, and those with greater than 220 ppb are definitely anomalous (Figure 5). Only water collected from streams in the vicinity of the Early Bird and Kootenay Florence mines show any anomalous concentrations of fluorine, and even so, the anomalies are rather subdued. Silver, lead and zinc in silts are locally enriched near some of the deposits (Table 25).

KECHIKA AREA

The Kechika yttrium and rare-earth prospect is located in the Cassiar Mountains of northern British Columbia, west of the Rocky Mountain Trench. It consists of a sequence of intrusive and extrusive alkaline igneous rocks, hosted by a fault-bounded package of Middle Silurian dolomites and siltstones that are exposed in a northwest-trending zone in excess of 20 kilometres long. The igneous rocks and host strata have been deformed and metamorphosed to greenschist facies during the Columbian Orogeny.

Igneous rocks are present in four main areas: medium-grained syenites and malignites are exposed at the southern end of the belt; a tuffisitic diatreme breccia pipe is present in the south-central area; a complex, southwest dipping homoclinal sequence of tuffs, agglomerates, trachytes, trachytic breccias, malignites, carbonatite and carbonatite breccia dikes and their sheared and altered equivalents, characterize the north-central region; and tuffs, agglomerates, trachytes and their sheared equivalents are found at the north end of the belt.

High-grade yttrium and heavy rare-earth element mineralization occurs in the north-central part of the property. Mineralization is stratabound, predominantly occurring in irregular, apatite-rich patches within a highly strained, locally mylonitic, quartz-feldspar-carbonate-sericite unit of possible trachytic protolith. Yttrium and heavy rare-earths occur in microscopic grains of xenotime and other rare-earth phosphates within apatite. Assays of up to 1.13 per cent Y_2O_3, 0.30 per cent Nd_2O_3, 0.11 per cent Sm_2O_3, 0.14 per cent Dy_2O_3 and 19.3 per cent P_2O_5 have been returned from this zone. Some yttrium values have also been found in carbonatite dikes, syenitic rocks, veins and metasomatic alteration zones elsewhere on the property. Carbonatite dikes may also locally contain up to 3.77 per cent cerium and lanthanum oxides. Fluorspar is found as disseminated grains within leucocratic syenites, in calcite-biotite-epidote veins and in pyrite-biotite alteration zones at the southern end of the belt; in

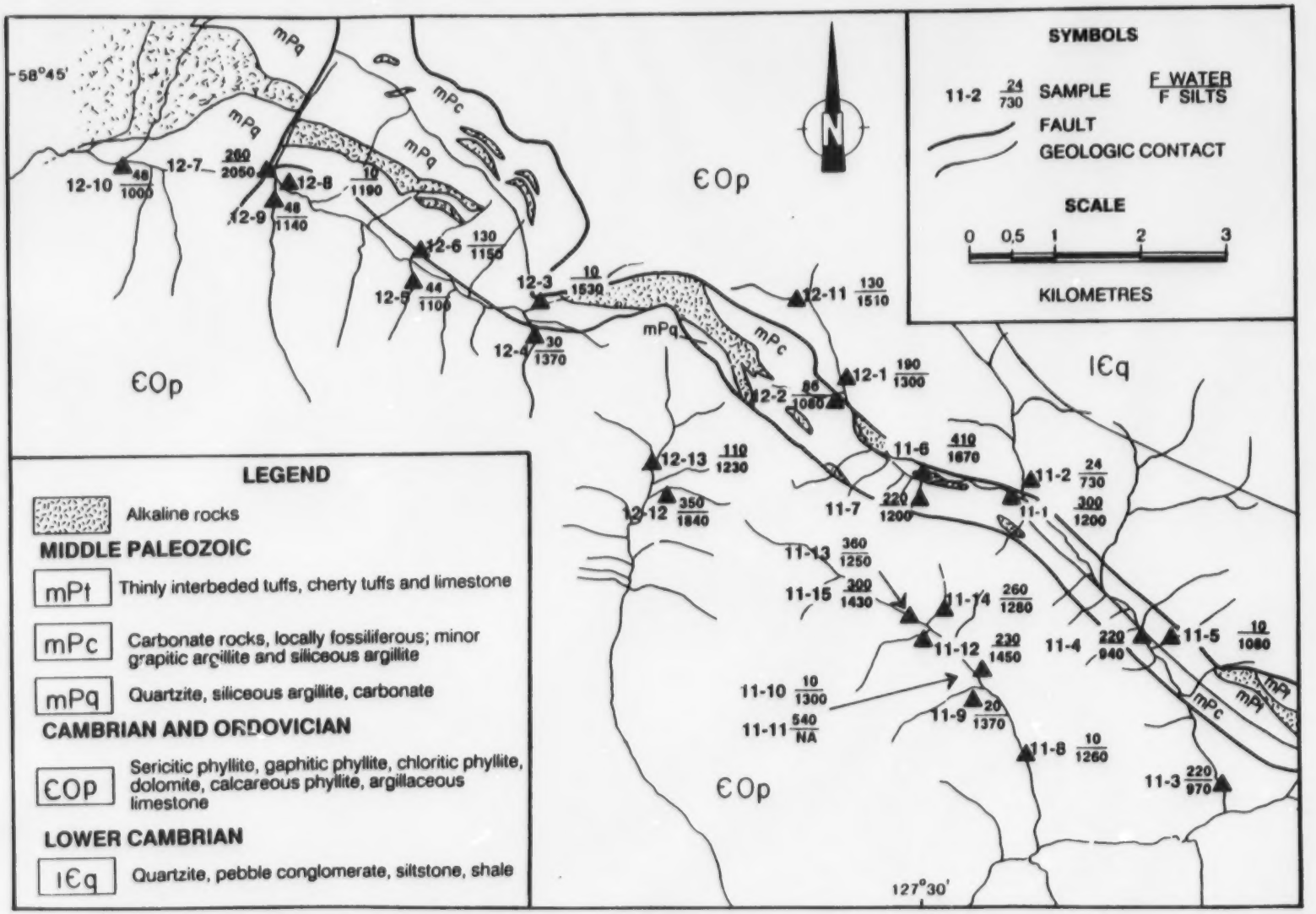


Figure 24. Fluorine-in-water and silts, Kechika area. Modified from Pell, Colbert and Fox, 1989.

calcite veins cutting the diatreme breccia in the south-central region; and, in veins and disseminated grains throughout various lithologies in the north-central region.

Many rocks collected from the Kechika area contain in excess of 1 per cent fluorine (Table 26) and often contain fluorite visible in hand sample. One sample of nearly pure fluorite (RE88/57A, Table 26) contains low silica, low arsenic, low phosphorus and high strontium. The majority of fluorine-enriched rocks also show moderate to high strontium levels. There does not appear to be a direct association with fluorine and rare earths, yttrium or barium; however some samples enriched in fluorine are also enriched in these elements. Some of the rocks containing greater than 1 per cent fluorine are also associated with anomalous molybdenum, lead, zinc and gold. Fluorine in water and silts from the Kechika area does not highlight the areas underlain by fluorite-bearing igneous rocks (Figure 24, Table 27 and 28). There does not appear to be any significant difference between streams which drain these areas and those which do not; however, there are no data from outside the immediate area and the regional geochemical patterson cannot be assessed.

TABLE 28
STREAM-SEDIMENT GEOCHEMISTRY, KECHIKA AREA (ppm)

SAMPLE NO.	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe%	As	U	Au	Th	Sr	Cd	Sb
94L/11 S1	2	20	23	79	0.1	28	11	540	2.22	12	5	1	9	154	1	3
94L/11 S2	1	27	10	33	0.1	34	14	420	2.58	11	5	0	7	147	1	2
94L/11 S3	1	17	12	39	0.1	21	11	507	2.28	10	5	0	10	200	1	2
94L/11 S4	1	27	21	43	0.1	20	10	444	2.00	4	5	0	9	153	1	2
94L/11 S5	1	19	7	26	0.1	18	12	320	1.78	4	5	0	11	152	1	2
94L/11 S6	2	27	23	63	0.1	30	11	581	2.43	8	5	0	15	159	1	2
94L/11 S7	1	31	26	80	0.1	28	13	381	3.03	12	5	0	13	182	1	2
94L/11 S8	1	35	18	88	0.2	30	13	393	3.02	2	5	0	11	180	1	2
94L/11 S9	1	32	14	85	0.1	32	14	380	3.81	2	5	0	10	137	1	2
94L/11 S10	1	38	18	90	0.1	29	13	406	3.63	2	5	0	12	204	1	2
94L/11 S12	1	34	10	71	0.1	30	12	317	3.44	2	5	0	10	143	1	2
94L/11 S13	1	29	11	75	0.1	28	13	371	3.43	2	5	0	10	168	1	2
94L/11 S14	1	24	53	124	0.1	27	14	313	2.84	16	5	0	16	221	1	2
94L/11 S15	1	28	9	71	0.1	22	12	323	2.97	2	5	0	10	148	1	2
94L/12 S1	1	16	12	28	0.3	15	6	472	1.61	6	5	0	8	116	1	4
94L/12 S2	1	29	28	84	0.1	27	10	486	2.64	7	5	0	12	192	1	2
94L/12 S3	1	33	12	89	0.1	28	12	361	2.81	7	5	0	15	135	1	2
94L/12 S4	1	28	14	94	0.1	34	15	349	3.97	2	5	0	9	115	1	2
94L/12 S5	1	30	12	73	0.1	31	12	389	3.48	2	5	0	9	186	1	2
94L/12 S6	1	26	13	70	0.1	27	13	399	3.32	2	5	0	11	179	1	2
94L/12 S7	2	23	15	60	0.4	26	10	286	2.38	10	5	1	10	61	1	3
94L/12 S8	1	24	13	64	0.3	23	11	416	3.08	4	5	0	9	196	1	2
94L/12 S9	1	32	11	80	0.1	28	14	362	3.69	2	5	0	9	189	1	2
94L/12 S10	1	33	32	67	0.2	22	12	408	3.11	4	5	0	8	234	1	2
94L/12 S11	2	27	18	45	0.1	48	16	584	3.01	8	5	0	19	123	1	2
94L/12 S12	2	40	38	73	0.1	37	15	587	3.67	18	5	0	18	144	1	2
94L/12 S13	1	33	14	88	0.1	32	16	394	4.04	2	5	0	11	130	1	2

SAMPLE NO.	Bi	V	Ca%	P%	La	Cr	Mg%	Ba	Ti%	B	Al%	Na%	K%	W	F
94L/11 S1	2	10	11.48	0.08	24	13	2.01	66	0.01	2.00	0.40	0.01	0.03	3.00	1200.00
94L/11 S2	2	5	10.47	0.58	26	11	1.37	11	0.01	2.00	0.84	0.01	0.01	2.00	730.00
94L/11 S3	2	9	13.01	0.74	28	11	1.99	48	0.01	2.00	0.49	0.01	0.02	3.00	970.00
94L/11 S4	3	8	10.56	0.85	25	9	1.65	29	0.01	2.00	0.38	0.01	0.01	2.00	940.00
94L/11 S5	2	3	10.59	0.13	19	7	0.75	8	0.01	2.00	0.80	0.01	0.01	2.00	1080.00
94L/11 S6	2	16	10.20	0.87	31	20	2.91	53	0.02	2.00	0.38	0.01	0.04	3.00	1870.00
94L/11 S7	2	5	8.24	0.55	40	13	1.34	14	0.01	2.00	0.89	0.01	0.02	1.00	1200.00
94L/11 S8	2	7	8.39	0.46	23	20	1.24	10	0.01	2.00	1.67	0.01	0.01	1.00	1280.00
94L/11 S9	2	8	8.30	0.48	17	21	1.22	8	0.01	2.00	1.64	0.01	0.01	1.00	1370.00
94L/11 S10	2	7	7.38	0.51	29	20	1.21	11	0.01	2.00	1.62	0.01	0.01	1.00	1300.00
94L/11 S12	2	7	6.77	0.50	9	20	1.26	6	0.01	2.00	1.69	0.01	0.02	1.00	1450.00
94L/11 S13	2	7	6.88	0.81	20	19	1.18	3	0.01	2.00	1.81	0.01	0.01	1.00	1260.00
94L/11 S14	2	3	10.32	0.48	53	10	0.77	8	0.01	2.00	0.76	0.01	0.01	1.00	1280.00
94L/11 S15	2	6	5.15	0.05	17	17	1.02	6	0.01	2.00	1.38	0.01	0.01	1.00	1430.00
94L/12 S1	2	16	10.66	0.46	14	14	4.32	66	0.01	2.00	0.18	0.01	0.03	3.00	1300.00
94L/12 S2	2	7	10.17	0.07	37	10	1.89	91	0.01	2.00	0.84	0.01	0.01	2.00	1080.00
94L/12 S3	2	5	8.14	0.05	39	14	1.05	21	0.01	2.00	0.97	0.01	0.02	1.00	1530.00
94L/12 S4	2	8	3.82	0.06	11	24	1.31	8	0.01	2.00	1.92	0.01	0.02	1.00	1370.00
94L/12 S5	2	8	7.42	0.06	10	20	1.26	12	0.01	2.00	1.68	0.01	0.02	1.00	1100.00
94L/12 S6	2	7	7.36	0.07	18	17	1.48	10	0.01	2.00	1.40	0.01	0.01	1.00	1150.00
94L/12 S7	2	6	4.77	0.06	31	9	1.56	36	0.01	2.00	0.43	0.01	0.04	1.00	2050.00
94L/12 S8	2	7	9.00	0.06	19	16	1.63	17	0.01	2.00	1.27	0.01	0.02	2.00	1190.00
94L/12 S9	2	8	7.18	0.05	8	21	1.53	13	0.01	2.00	1.80	0.01	0.02	1.00	1140.00
94L/12 S10	2	7	9.63	0.05	12	17	1.61	15	0.01	2.00	1.36	0.01	0.02	1.00	1000.00
94L/12 S11	2	17	7.23	0.10	34	52	1.47	68	0.03	4.00	0.83	0.01	0.07	1.00	1510.00
94L/12 S12	2	16	6.19	0.09	34	22	1.26	223	0.02	2.00	1.01	0.01	0.04	1.00	1840.00
94L/12 S13	2	9	4.41	0.06	14	24	1.41	20	0.01	2.00	2.07	0.01	0.02	1.00	1230.00

EVALUATION OF REGIONAL GEOCHEMICAL SURVEY FLUORINE-IN-WATER DATA, SOUTHERN BRITISH COLUMBIA

Fluorine-in-water data from the Regional Geochemical Surveys (RGS) for the southern part of the province (Figures 4 to 9) were statistically analyzed in order to define threshold values which separate background from anomalous populations for catchment basins underlain by different rock types. Probability graphs (Sinclair, 1976) were plotted using the PROBPLOT program (Stanley, 1987) in order to determine these thresholds. For most areas in southern British Columbia threshold values of between 100 and 200 ppb fluorine-in-water separate anomalous from background populations. Thresholds of less than 100 ppb were calculated for some areas underlain by schists, gneisses and quartzites. Thresholds of greater than 200 ppb were calculated for areas underlain by Marron Formation andesites in NTS 82E (Figure 4), for granites, Kaslo Group andesites and Slocan Group siltstones and schists in NTS 82K (Figure 6), for granites and gneisses in NTS 82L and 92I E$^1/_2$ (Figure 7) and for Eocene alkali olivine basalts in NTS 93A (Figure 9). In order to graphically represent areas containing near threshold or anomalous fluorine-in-water only values greater than 100 ppb are shown (Figures 4 to 9).

In NTS Map 82E (Figure 4) high fluorine-in-water values are common in most of the southern part of the area and absent in the north. This, in part, reflects bedrock geology; Marron Formation alkaline volcanic rocks and granites and quartz monzonites of the Nelson intrusions dominate the southern part of the area, while metamorphic rocks of the Shuswap Complex are present in the north. Waters from streams flowing through areas underlain by Marron Formation volcanic rocks are characterized by high background fluorine values (450 ppb threshold) and therefore, only values of over 500 ppb fluorine-in-water can be considered anomalous in these areas. The largest true anomaly is present in a northwest-trending belt running from southeast of Oliver to west-southwest of Penticton. It corresponds with areas underlain by Marron Formation rocks and Jurassic intrusions. The Oliver Silica, Skaha and Dusty Mac fluorspar occurrences are peripheral to this belt. Another significantly anomalous area is present on the west slopes of the Kettle River valley, on the east flank of the Beaverdell Range. This area is underlain by Jurassic Nelson intrusions. No fluorspar occurrences are known from this area. A weak fluorine-in-water anomaly is present surrounding the fluorspar occurrences in the Beaverdell-Carmi area, on the west flank of the Beaverdell Range. Fluorspar mineralization at the Rock Candy mine is not emphasized by fluorine-in-water chemistry on the regional scale.

In NTS 82F (Figure 5) anomalous fluorine-in-water values are scarce; most commonly they are associated with certain phases of the Nelson intrusions, often found along the margins of the granites. The Fry Creek and White Creek batholiths, east of Kootenay Lake and west of Skookumchuck, respectively, are two such granitic intrusions. Weak fluorine-in-water anomalies are associated with fluorspar occurrences in the Silverton and Ainsworth districts; fluorspar occurrences in molybdenum-copper-tungston skarn mineralization west of Ymir have no associated fluorine-in-water anomalies.

Fluorine-in-water anomalies in NTS 82K (Figure 6) are well developed around the margins of the Kuskanax batholith, particularly along its southwestern margin, south of Nakusp, however, no fluorspar occurrences are reported from this area. Other anomalies occur in the vicinity of various Jurassic granitic batholiths, particularly the Fry Creek batholith, east of Kootenay Lake. Fluorspar is reported from a skarn occurrence along its northern margin of the and also in placer deposits on Bugaboo and Forster creeks which drain areas underlain by Jurassic granitic intrusions. In the northwestern part of the area, near Akolkolex Creek, fluorspar is associated with a base metal replacement occurrence. A fluorine-in-water anomaly is associated with this showing.

High (100 ppb) to weakly anomalous fluorine-in-water contents are associated with a broad belt in the centre of NTS map areas 82L and 92I E$^1/_2$ (Figure 7). This area is underlain predominantly by Miocene alkali olivine basalts and Jurassic granites. There are a number of fluorspar occurrences (Whiteman Creek, Little Shuswap, To, Tappen Creek, Redbird, Cindy) in this region and all are associated with weak anomalies. Areas underlain by

PreCambrian gneisses are generally characterized by low fluorine-in-water values.

Some weak fluorine-in-water anomalies occur in areas underlain by Jurassic granites in the southwest corner of NTS 82M and 92P E½ (Figure 8). There is also an anomaly along the southwest flank of Frenchman Cap gneiss dome, northwest of Revelstoke, in an area which contains a number of fluorspar occurrences. The Ruddock Creek lead-zinc deposit, north of Frenchman Cap, reportedly contains significant amounts of fluorite, but has associated fluorine anomaly. A strong fluorine-in-water anomaly occurs in the vicinity of the Rexspar deposit, clearly indicative of the fluorspar mineralization in that locality. Scattered, weak anomalies are present in the northwestern corner of the area, which is underlain by Miocene alkali olivine basalts and Takla Group argillites and is not known to host any fluorspar occurrences.

In NTS 93A (Figure 9), anomalous fluorine-in-water data is sparce. A small anomaly occurs in the vicinity of the Eaglet fluorspar property. Some weak anomalies are also present in the southwestern part of the map, in areas underlain by Miocene alkali olivine basalts and sediments of the Cache Creek Terrane.

Although fluorine-in-water and silt anomalies are not always directly correlative with known fluorspar occurrences, fluorine is a useful prospecting tool. In some instances, there is a direct correlation with fluorspar mineralization. Fluorine geochemistry helps define, in a general way, areas with geologic environments favourable for fluorspar deposits, as well as other types of mineralization. Porphyry molybdenum, tin, tungsten, carbonate-hosted lead-zinc and rare-earth deposits may have associated fluorine anomalies.

DISCUSSION AND CONCLUSIONS

Fluorspar mineralization in British Columbia occurs in a wide range of geologic environments and tectonic settings. Fluids (volatiles) are always important in the mineralizing process. Where fluorspar is associated with igneous systems, the late-stage differentiated fluids that were fractionated during crystallization are often enriched in incompatible elements (be it in granitic or alkaline systems) and play an important role.

Five significant fluorspar prospects are known in British Columbia. The Rock Candy mine, a vein deposit of probable late Tertiary age associated with the Coryell intrusions, occurs in the southern Omineca Belt and has a history of past production. The Eaglet fluorspar property consists of veins and replacements, of possible Cretaceous age, in the Quesnel Lake gneiss at the western margin of the Omineca Belt in central British Columbia. The Rexspar deposit, which is located along the western margin of the Omineca Belt in south-central British Columbia, comprises separate zones of fluorspar and uranium mineralization of volcanogenic origin, related to alkaline tuffs. Mineralization at Rexspar is considered to be syngenetic and Devono-Mississippian in age. The Deep Purple prospect on Rock Canyon Creek, in the Foreland Belt of southern British Columbia, is a metasomatic replacement deposit interpreted to be related to a carbonatite - alkaline suite. Mineralization at Deep Purple is probably Devono-Mississippian to Early Mississippian in age. The Foreland Belt of northern British Columbia contains the carbonate-hosted Liard fluorspar showings which are apparently related to carbonate-hosted lead-zinc deposits farther to the south and formed by dewatering of the sedimentary basin in the Late Devonian.

A number of showings containing abundant fluorspar are also known. The Redbird property, located in the eastern Intermontane Belt, covers veins of epithermal fluorite and chalcedonic quartz hosted by Triassic Nicola Group volcanics. The Gypo (Oliver Silica) quarry near Oliver, the Whiteman Creek property near Vernon and the Galena Farm property near Silverton are all examples of quartz-fluorite and quartz-fluorite-lead-zinc-silver veins associated with Jurassic or Cretaceous granites and quartz monzonites in the Omineca Belt.

Numerous other showings occur throughout the province, but the major deposits and significant showings are confined to the Foreland and Omineca belts and eastern parts of the Intermontane Belt, which suggests that these areas are most favourable for future exploration. Some deposits with abundant fluorspar are reported from the Atlin area in the northern Intermontane Belt; this area also warrants exploration attention. The majority of fluorite deposits in British Columbia are underlain by crust with Mesozoic or Cenozoic $^{87}Sr/^{86}Sr$ initial ratios of greater than 0.704 (Figure 25). Areas with ratios of 0.707 or greater are underlain by Precambrian crust that has been incorporated into younger magmas; initial ratios of between 0.704 and 0.707 are indicative of areas underlain by reworked Precambrian basement or Proterozoic continent-derived sediments. Initial ratios of less than 0.704 are indicative of areas underlain by ensimatic Phanerozoic crust (Armstrong, 1985). The fluorite deposits are formed, preferentially in areas underlain by continental (sialic) basement or continent-derived basement rocks. Areas with $^{87}Sr/^{86}Sr$ initial ratios of less than 0.704 are unlikely to host fluorspar deposits.

Of the known fluorspar deposits, the Rexspar property appears to have the best immediate potential. It is well located close to infrastructure, has well-developed access and significant proven reserves of mineable grade near surface. Its proximity to known uranium mineralization is, however, problematic. As well, preliminary beneficiation failed to produce an acid grade concentrate. The Liard fluorspar showings appear to have the size and grade to be potentially economic, and acid grade concentrates were produced in preliminalry beneficiation tests. However, distance from market and high transportation costs preclude development in the near future. Follow-up on fluorine-in-water anomalies outlined in existing and future Regional Geochemical Surveys may well lead to the discovery of new and potentially economic fluorspar showings.

In 1986, the United States imported 389 000 tonnes of fluorspar and 103 000 tonnes of hydrofluoric acid. About one half of these imports come from South Africa. Trade restrictions with South Africa, if continued, may provide an opportunity for Canadian producers of low-phosphorus and low-arsenic fluorspar to penetrate the American market. Under the Free Trade Agreement, the tariff on Canadian fluorspar imports to the U.S. will be removed which should also encourage new producers.

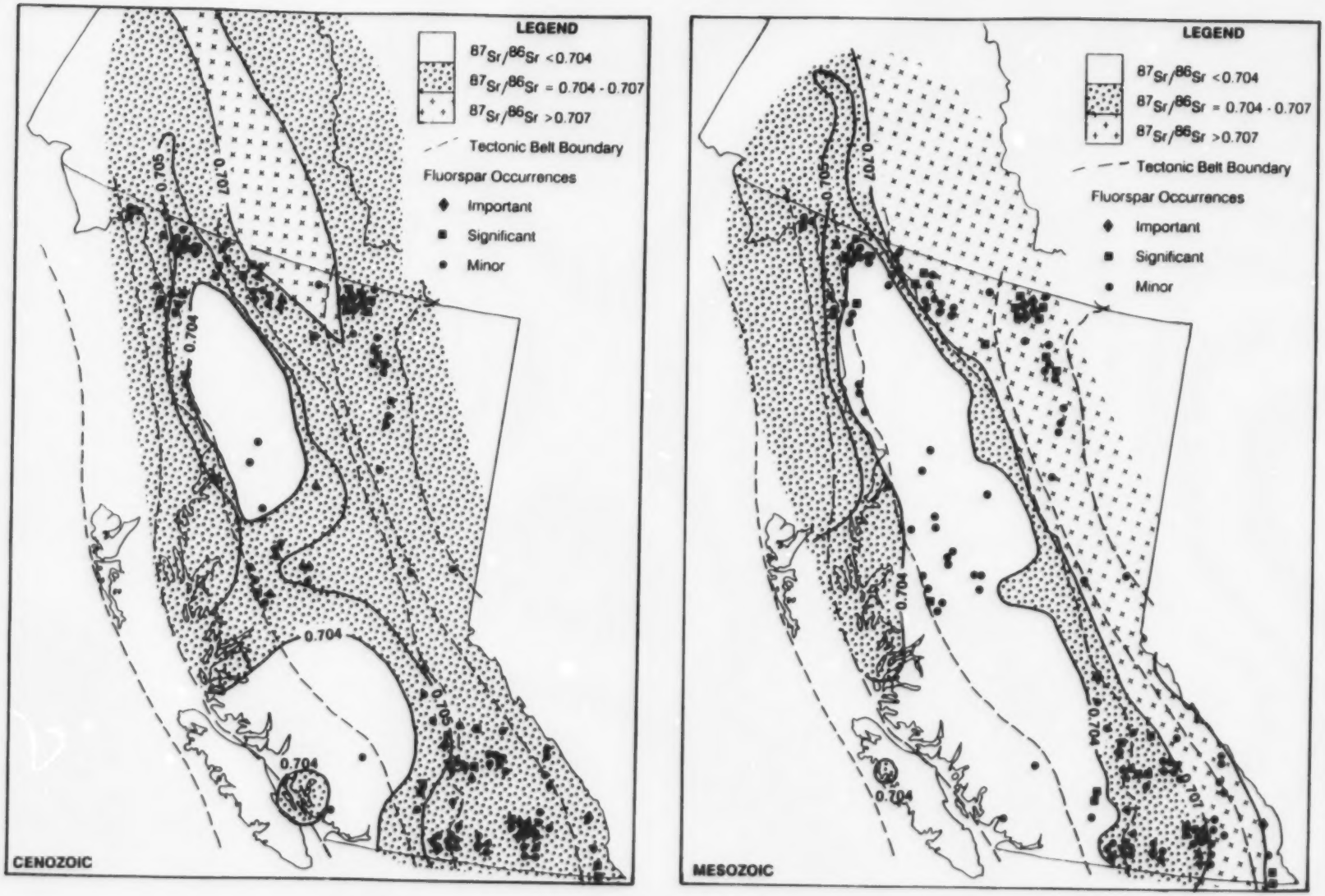


Figure 25. Fluorspar occurrences as related to $^{87}/Sr/^{86}Sr$ ratios (modified from Armstrong, 1985).

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APPENDIX

FLUORSPAR OCCURRENCES IN BRITISH COLUMBIA

* denotes properties with significant amount of fluorite present,

** denotes fluorspar showing or prospect.

001. *OLIVERSILICAQUARRY(GYPO)
NTS 82E/4E, MINFILE No. 082ESW084, 49°11.6', 119°33.4'
DEPOSIT CLASS: Large lensoid vein
COMMODITIES: Si
HOSTROCKS: Quartz monzonite, Oliver plutonic complex
FLUORITE: Present as a significant associated mineral, approximately 29.5 tonnes shipped to market in 1958; colourless to pale green

002. DUSTY MAC
NTS 82E/5E, MINFILE No. 082ESW078, 49°20', 119°32'
DEPOSIT CLASS: Vein
COMMODITIES: Au, Ag, Cu
HOSTROCKS: Eocene volcanics, White Lake Formation
FLUORITE: Minor accessory mineral

003. SKAHA RESERVATION
NTS 82E/5E, MINFILE No. 082ESW176, 49°27', 119°38.5'
DEPOSIT CLASS: Stratabound alteration
COMMODITIES: Th, U
HOSTROCKS: Pink grits, tuffs and volcanic sandstones of the Yellow Lake member, Marron Formation
FLUORITE: Associated with zoisite in alteration zones in the most radioactive rocks

004. HIGHLAND BELL (BELL, BEAVERDELL)
NTS 82E/6E, MINFILE No. 082ESW030 & 115, 49°26.1', 119°03.8'
DEPOSIT CLASS: Veins and stockworks
COMMODITIES: Ag, Pb, Zn, minor Au, Cu
HOSTROCKS: Beaverdell quartz monzonite, Valhalla intrusions
FLUORITE: Rare trace mineral, associated with calcite in vugs within veins and along vein margins at Highland Bell and other properties in the Beaverdell camp; green and purple in colour

005. HIGHLAND LASS
NTS 82E/6E, MINFILE No. 082ESW133, 49°25.9', 119°03.5'
DEPOSIT CLASS: Vein
COMMODITIES: Ag, Pb, Zn, minor Au
HOSTROCKS: Beaverdell quartz monzonite, Valhalla intrusions
FLUORITE: Rare trace mineral in quartz veins

006. MATT (MO)
NTS 82E/6E, MINFILE No. 082ESW058, 49°22.8', 119°08'
DEPOSIT CLASS: Porphyry Mo-Cu
COMMODITIES: Mo, Cu
HOSTROCKS: Valhalla intrusions
FLUORITE: Present in minor amounts as disseminated purple grains in altered quartz monzonite; reportedly associated with minor topaz

007. CARMI (B.A. FR., Lot 2352 & Lot 2357)
NTS 82E/6E, MINFILE No. 082ESW029, 49°29.5', 119°07.5'
DEPOSIT CLASS: Vein
COMMODITIES: Au, Ag, minor Pb, Zn, Mo, Cu
HOSTROCKS: Nelson plutonic complex
FLUORITE: Rare trace mineral

008. MAY (L.2355)
NTS 82E/6E, MINFILE No. 082ESE103, 49°29.6', 119°08.2'
DEPOSIT CLASS: Breccia pipe associated with a porphyry system
COMMODITIES: Ag, Pb, minor Mo, Cu
HOSTROCKS: Nelson plutonic complex
FLUORITE: Accessory mineral associated with molybdenite, pyrite and chalcopyrite

009. CAPCO
NTS 82E/6E, MINFILE No. 082ESE104, 49°29.3', 119°08.9'
DEPOSIT CLASS: Skarn
COMMODITIES: Cu, Ni, Mo
HOSTROCKS: Nelson plutonic complex (?)
FLUORITE: Rare trace mineral

010. MIDAS (DEER)
NTS 82E/8E, MINFILE No. 082ESE162, 49°20.3', 118°02.5'
DEPOSIT CLASS: Quartz stockwork veins (porphyry system?)
COMMODITIES: Mo, Cu, minor Zn & W
HOSTROCKS: Syenite, Coryell intrusions
FLUORITE: Accessory mineral in veinlets, shears, fracture coatings, vugs and irregular patches in alteration zones

011. WEWA (RAM)
NTS 82E/8E, MINFILE No. 082ESE167, 49°17', 118°00.2'
DEPOSIT CLASS: Fracture and breccia fillings in a Mo-Cu porphyry system
COMMODITIES: Mo, Cu
HOSTROCKS: Monzonites and diorites of the Nelson plutonic complex
FLUORITE: Minor mineral coating fractures and in fault breccias

012. **ROCK CANDY MINE
NTS 82E/8W, MINFILE No. 082ESE070, 49°15.6', 118°29.3'
DEPOSIT CLASS: Vein
COMMODITIES: Fluorite
HOSTROCKS: Coryell syenites and Marron Formation volcanics
FLUORITE: Past-producing deposit of green and purple fluorspar in two main veins up to 2 m in width; 51 850 t of 68% CaF_2 were mined between 1918 and 1929; associated minerals include chalcedony, kaolin, barite, quartz and minor chalcopyrite, galena, pyrite, chalcocite and covellite

013. KINGFISHER (MAPLE LEAF, Lot 1609)
NTS 82E/9W, MINFILE No. 082ENE009, 49°33.9', 118°21.4'

DEPOSIT CLASS: Porphyry Cu with vein and disseminated mineralization
HOSTROCKS: Syenites and shonkinites, Coryell intrusions
COMMODITIES: Cu, Pb, Zn, minor Au, Ag
FLUORITE: Bluish in colour, occurs as cavity fillings and fracture coatings in melanite syenite, probably of igneous metasomatic origin; also present in veins

014. CARMI MOLY (DOE, IVY, FAN)
NTS 82E/11E, MINFILE No. 082ENW036, 49°31', 119°09.9'
DEPOSIT CLASS: Porphyry Mo-Cu
COMMODITIES: Mo, Cu, U
HOSTROCKS: Nelson plutonic complex
FLUORITE: Present in trace amounts as disseminated purple grains associated with uraninite in altered granodiorite and granodiorite breccia

015. ELM
NTS 82F/6E, MINFILE No. 082FSW057, 49°15.8', 117°07.6'
DEPOSIT CLASS: Sulphide lenses in limestones associated with granitic dikes
COMMODITIES: Zn
HOSTROCKS: Limestones, Active Formation
FLUORITE: Trace, minor scheelite also present

016. MAMMOTH (Lot 14694, MONARCH)
NTS 82F/6E, MINFILE No. 082FSW211, 49°21.5', 117°17'
DEPOSIT CLASS: Skarn
COMMODITIES: Mo, Cu, minor Pb, Zn, Ag
HOSTROCKS: Volcanics and sediments of the Elise and Hall formations and Rossland Group, altered to skarn adjacent to Nelson granite
FLUORITE: Trace reported

017. STEWART
NTS 82F/6W, MINFILE No. 082FSW229, 49°16.9', 117°15.9'
DEPOSIT CLASS: Skarn
COMMODITIES: Mo, W
HOSTROCKS: Rossland Group, intruded by Nelson granitic and Coryell syenitic-monzonitic rocks
FLUORITE: Trace reported

018. ARROW TUNGSTEN
NTS 82F/6W, MINFILE No. 082FSW311, 49°17.9', 117°15.9'
DEPOSIT CLASS: Skarn
COMMODITIES: W, Mo
HOSTROCKS: Hall Formation sediments adjacent to the Stewart intrusive complex
FLUORITE: Trace reported

019. DAVE
NTS 82F/10E, MINFILE No. 082FNE138, 49°30.7', 116°40'
DEPOSIT CLASS: Replacement and vein
COMMODITIES: Pb, Zn, Ag
HOSTROCKS: Limestones and quartzites, Middle Proterozoic Dutch Creek Formation
FLUORITE: Accessory, in veins

020. SILVER HOARD (DELLIE, LITTLE MAY, Lots 10712 & 241)
NTS 82F/10W, MINFILE No. 082FNE024, 49°44.9', 116°57'
DEPOSIT CLASS: Vein and replacement (Ainsworth camp)
COMMODITIES: Ag, Pb, Zn
HOSTROCKS: Limestones, Lardeau Group
FLUORITE: Accessory to locally common gangue mineral; green

021. NO. ONE MINE
NTS 82F/10W, MINFILE No. 082FNE025, 49°44.4', 116°56.8'
DEPOSIT CLASS: Vein (Ainsworth camp)
COMMODITIES: Ag, Pb, Zn
HOSTROCKS: Lardeau Group
FLUORITE: Minor gangue mineral; green

022. HIGHLANDER
NTS 82F/10W, MINFILE No. 082FNE030, 49°43.3', 116°54.7'
DEPOSIT CLASS: Vein (Ainsworth camp)
COMMODITIES: Ag, Pb, Zn
HOSTROCKS: Mica schists, Lardeau Group
FLUORITE: Accessory, locally common gangue; green

023. *FIVEMILE POINT
NTS 82F/11E, MINFILE No. 082FNW241, 49°33', 117°14.5'
DEPOSIT CLASS: Vein
COMMODITIES: Fluorspar
HOSTROCKS: Granite, Nelson plutonic complex
FLUORITE: Blue and purple in colour; approximately 30 cm of pure fluorspar occupies the centre of a vein up to 1 m in width; vein margins contain mixed fluorite and country rock fragments; minor barite is also reported; a few tonnes were mined from an adit in 1904 but found to contain a higher silica content than was desirable

024. MOUNTAIN CHIEF (APEX, MOUNTAIN CHIEF NO 2, Lot 474)
NTS 82F/14W, MINFILE No. 082FNW001 & 177, 49°59.5', 117°20'DEPOSIT CLASS: Vein
COMMODITIES: Ag, Pb, Zn, Au
HOSTROCKS: Argillaceous and calcareous schists, Slocan Group
FLUORITE: Noted as an accessory gangue mineral

025. *GALENA FARM (CURRIE, GROVER, PEERLESS, KATE, Lots 744, 1330, 1332, 1333)
NTS 82F/14W, MINFILE No. 082FNW067, 49°55.8', 117°21.7'
DEPOSIT CLASS: Vein
COMMODITIES: Zn, Pb, Ag
HOSTROCKS: Quartzites and schists, Slocan Group and granitic rocks of the Nelson plutonic complex
FLUORITE: Colourless to pale purple; common gangue mineral, locally more abundant than quartz or siderite

026. RKY-DKY
NTS 82F/14W, MINFILE No. 082FNW256, 49°48.9', 117°24'
DEPOSIT CLASS: Vein

COMMODITIES: Ag, Au
HOSTROCKS: Porphyritic granite, Nelson plutonic complex
FLUORITE: A few fluorite veinlets were noted on the property

027. LOKI
NTS 82F/15E, MINFILE No. 082FNE085, 49°50.1', 116°43'
DEPOSIT CLASS: Greisen vein system
COMMODITIES: Mo, minor W
HOSTROCKS: Quartz monzonite, Fry Creek batholith
FLUORITE: Accessory in veins

028. EARLY BIRD
NTS 82F/15W, MINFILE No. 0882FNE017, 49°45.6', 116°54.6'
DEPOSIT CLASS: Vein (Ainsworth camp)
COMMODITIES: Pb, Zn, Ag
HOSTROCKS: Micaceous limestones, Lardeau Group
FLUORITE: Accessory to common gangue mineral, associated with calcite; pink and purple varieties present

029. KOOTENAY FLORENCE (FLORENCE, WESTERN)
NTS 82F/15W, MINFILE No. 082FNE016, 49°45.9', 116°55'
DEPOSIT CLASS: Vein (Ainsworth camp)
COMMODITIES: Pb, Zn, Ag, minor Au
HOSTROCKS: Limestones, Lardeau Group
FLUORITE: Accessory mineral; green; coarse crystals line vugs in quartz-carbonate veins

030. WHITE CREEK BATHOLITH
NTS 82F/16, 49°59', 116°12'
DEPOSIT CLASS: Igneous
COMMODITIES: N/A
HOSTROCKS: Leuco quartz monzonite, White Creek batholith
FLUORITE: Rare trace, as patches in plagioclase

031. *HOWELL CREEK (ROK, CAT)
NTS 82G/2E, MINFILE No. 082GSE037, 048, 49°13.2', 114°39.7'
DEPOSIT CLASS: Alkaline porphyry system
COMMODITIES: Au, Fluorite
HOSTROCKS: Upper Proterozoic to Paleozoic (Devonian) platformal carbonates and clastics intruded by syenites and tinguaites of probable Tertiary age
FLUORITE: Purple to black; occurs as disseminated grains and cavity lining in the alkaline igneous rocks, as breccia fillings and as disseminated grains and replacement patches in carbonate rocks

032. *HOWELL (FLATHEAD)
NTS 82G/2E, MINFILE No. 082GSE048, 49°14.1', 114°43.7'
DEPOSIT CLASS: Alkaline porphyry system
COMMODITIES: Fluorite, Au, minor Pb, Zn
HOSTROCKS: Upper Proterozoic to Paleozoic (Devonian) platformal carbonates and clastics intruded by syenites and trachytes of probable Tertiary age
FLUORITE: Purple; occurs as fracture infillings in silicified areas or in late quartz veins in carbonate rocks near the intrusions; associated with pyrite, galena, sphalerite, barite and minor chalcopyrite and chalcocite

033. CROW
NTS 82G/10, MINFILE No. 082GNE031, 49°39.8', 114°42.5'
DEPOSIT CLASS: Sedimentary phosphorite
COMMODITIES: Phosphate
HOSTROCK: Phosphorite, Jurassic Fernie Formation
FLUORITE: Minor, in veinlets and open space fillings associated with the fluorapatite-rich phosphate horizon

034. **DEEP PURPLE (CANDY, ROCK CANYON CREEK)
NTS 82J/3E, MINFILE No. 082JSW018, 50°12', 115°08'
DEPOSIT CLASS: Metasomatic replacement
COMMODITIES: Fluorite, light rare-earths
HOSTROCKS: Devonian carbonates
FLUORITE: Purple to black fluorspar occurs as disseminated grains and fracture coatings in altered carbonates; purple to white fluorspar is present as massive replacement bodies associated with prosopite, barite and calcite; and purple fluorite is present as limestone breccia matrix

035. PEGLEG
NTS 82K/2E, MINFILE No. 082KSE069, 50°04.5', 116°43'
DEPOSIT CLASS: Skarn
COMMODITIES: Mo
HOSTROCKS: Limestone and quartzite inclusions in granite of the Fry Creek batholith
FLUORITE: Associated with garnet, titanite, quartz, pyroxene and scapolite replacing sedimentary inlier

036. FORSTER
NTS 82K/9W, MINFILE No. 082KNE005, 50°39.1', 116°23.6'
DEPOSIT CLASS: Placer
COMMODITIES: U, Nb
HOSTROCKS: Sands and gravels
FLUORITE: Associated with niobium and uranium minerals in heavy mineral concentrates derived from Horsethief granitic stock

037. WIGWAM
NTS 82K/13W, MINFILE No. 082KNW068, 50°52.8', 117°58'
DEPOSIT CLASS: Replacement
COMMODITIES: Zn, Pb, minor Ag, Cu
HOSTROCKS: Lower Paleozoic carbonates of the Hamill, Mohican and Badshot formations
FLUORITE: Generally rare trace mineral; locally, in the vicinity of one of the adits, violet coarse-grained fluorspar is present associated with graphite and magnetite

038. BUGABOO (BUGABOO PLACER)
NTS 82K/15E, MINFILE No. 082KNE075, 50°45', 116°42.5'
DEPOSIT CLASS: Placer
COMMODITIES: Nb, U
HOSTROCKS: Sands and gravels
FLUORITE: Present in heavy mineral concentrates from Bugaboo and Vowell creeks, associated with Nb and U-bearing minerals

039. *WHITEMAN CREEK FLUORITE (VIEW, GREEN GABLES, LAKEVIEW, BURSARY MOUNTAIN FLUORITE)

NTS 82L/3W, MINFILE No. 082LSW001, 50°12.9', 119°28.6'
DEPOSIT CLASS: Epithermal vein
COMMODITIES: Fluorite
HOSTROCKS: Quartz monzonite
FLUORITE: Commonly green; purple, rose and white varieties also present; often well-formed crystals present lining cavities; associated with drusy quartz; veins pinch and swell and can reach 1 m in thickness

040. BRIGHT STAR (X5, GOLDEN WEST, DEAR, BRIGHT STAR TRIO, MABEL LAKE, KINGFISHER, SILVER KING)
NTS 82L/10W, MINFILE No. 082LNE003, 50°42.7', 118°45.1'
DEPOSIT CLASS: Replacement
COMMODITIES: Zn, Pb, Cu, Ag
HOSTROCKS: Shuswap Complex marble
FLUORITE: Trace, in replacement lenses of massive quartz, pyrrhotite, sphalerite, galena, chalcopyrite and pyrite

041. *TO
NTS 82L/13E, MINFILE No. 082LNW034, 50°49.3', 119°40.4'
DEPOSIT CLASS: Vein
COMMODITIES: Fluorite
HOSTROCKS: Granitic to dioritic gneisses, Little Shuswap gneiss and mica schists and amphibolites, Silver Creek Formation; some syenite also reportedly present
FLUORITE: Coating fractures and in veins up to 20 cm wide, with quartz; fluorite veins occur over a distance of 485 m

042. LITTLE SHUSWAP LAKE
NTS 82L/13E, MINFILE No. 082LNW048, 50°50.8', 119°39.8'
DEPOSIT CLASS: Vein
COMMODITIES: Fluorite
HOSTROCKS: Granitic gneisses, Little Shuswap gneiss
FLUORITE: Rare quartz veinlets contain crystals of pale purple fluorite; first reported fluorspar locality in the province

043. *TAPPEN CREEK
NTS 82L/14W, MINFILE No. 082LNW049, 50°46.8', 119°23.8'
DEPOSIT CLASS: Vein
COMMODITIES: Fluorite
HOSTROCKS: Granite, Salmon Arm pluton
FLUORITE: Occurs in irregular veinlets up to 10 cm wide

044. MASTADON (MASTODON, ERIC, Lot 15617)
NTS 82M/1E, MINFILE No. 082M005, 51°14.4', 118°07.2'
DEPOSIT CLASS: Disseminated replacement & vein
COMMODITIES: Zn, Pb, Ag
HOSTROCKS: Limestones and phyllites of the Cambrian and Ordovician Badshot Formation and Lardeau Group
FLUORITE: White and mauve; present as an accessory gangue mineral in irregular veinlets with quartz and barite

045. MASTODON NORTH
NTS 82M/1E, MINFILE No. 082M195, 51°15', 118°07.1'
DEPOSIT CLASS: Disseminated replacement & vein
COMMODITIES: Zn, Pb, Ag, Au, Cu
HOSTROCKS: Limestones and phyllites of the Cambrian and Ordovician Badshot Formation and Lardeau Group
FLUORITE: White and mauve; present as an accessory gangue mineral in irregular veinlets with quartz and barite

046. RIVER JORDAN (KING FISSURE, COPELAND, DEBY)
NTS 82M/1W, MINFILE No. 082M001, 51°07.5', 118°24.6'
DEPOSIT CLASS: Sedimentary exhalative
COMMODITIES: Pb, Zn, Ag
HOSTROCKS: Impure marbles, Monashee Complex mantling gneisses
FLUORITE: Trace

047. MOUNT COPELAND (JOAN, KNOX)
NTS 82M/1W, MINFILE No. 082M002, 51°07.8', 118°27.5'
DEPOSIT CLASS: Alkaline syenite related Mo
COMMODITIES: Mo, minor Zn, Pb, Cu
HOSTROCKS: Mount Copeland syenite gneisses
FLUORITE: Trace

048. *HIREN CREEK (BINGO)
NTS 82M/1W, MINFILE No. 082M096, 51°05', 118°22.9'
DEPOSIT CLASS: Vein, disseminated
COMMODITIES: Pb, Zn
HOSTROCKS: Calcsilicate gneisses and marbles of the Frenchman Cap mantling gneiss succession
FLUORITE: Masses of purple fluorite are present south of an area of disseminated galena-sphalerite-pyrite mineralization

049. MOUNT COPELAND SYENITE GNEISS
NTS 82M/1W, 51°07', 118°27'
DEPOSIT CLASS: Igneous
COMMODITIES: N/A
HOSTROCKS: Nepheline-poor syenite gneisses
FLUORITE: Accessory mineral

050. *REXSPAR (G ZONE, FOGHORN CK MOLY)
NTS 82M/12W, MINFILE No. 082M021, 022 & 043, 51°33.6', 119°54.6'
DEPOSIT CLASS: Volcanogenic sulphides overprinted by deuteric alteration (replacement)
COMMODITIES: U, Th, light rare-earths, fluorspar, Mo
HOSTROCKS: Eagle Bay trachytic volcanics and lithic tuffs
FLUORITE: Dark purple to black; largely fine grained, in stratiform replacement zones; also some coarse crystalline fluorite in augen or small lenses

051. **REXSPAR FLUORITE ZONE (SPAR, SMUGGLER)
NTS 82M/12W, MINFILE No. 082M007 & 023, 51°33.8', 119°54.4'
DEPOSIT CLASS: Stratabound deuteric alteration (replacement) zone, vein
COMMODITIES: Fluorspar, Sr, minor Mo, Ag, Cu
HOSTROCKS: Eagle Bay trachytic volcanics and lithic tuffs

FLUORITE: Present as purple, coarse-grained fragments or disseminated, fine-grained replacement in lithic tuffs; light purple to white, coarse-grained fluorspar occurs in veins, locally with minor chalcopyrite and celestite; the zone is 400x50x24 m and contains an estimated 1 441 820 t of ore averaging 23.46% CaF_2

052. CK
NTS 82M/13E, MINFILE No. 082M224, 51°54.7', 119°34.2'
DEPOSIT CLASS: Sedimentary exhalative
COMMODITIES: Zn, Pb, Cu
HOSTROCKS: Metasedimentary rocks, Shuswap metamorphic complex
FLUORITE: Occurs locally as a gangue mineral in the massive sulphide layer

053. *RUDDOCK CK (IN, TO, IT)
NTS 82M/15W, MINFILE No. 082M082, 083 & 084, 51°46.5', 118°54.5'
DEPOSIT CLASS: Sedimentary exhalative
COMMODITIES: Zn, Pb, Ag
HOSTROCKS: Micaceous and calcsilicate schists, Shuswap metamorphic complex
FLUORITE: Abundant, white and purple; disseminated, locally massive, gangue within the sulphide layer

054. TRIDENT CREEK
NTS 82M/16E, MINFILE No. 082M077, 51°57', 11°03.6'
DEPOSIT CLASS: Placer
COMMODITIES: Nb, U, Th
HOSTROCKS: Sands and gravels derived from the Trident Mountain nepheline syenite
FLUORITE: Accessory in heavy mineral concentrates

055. SILVER CREEK
NTS 82N/4W, MINFILE No. 082N068, 51°07.2', 117°54.3'
DEPOSIT CLASS: N/A
COMMODITIES: N/A
HOSTROCKS: Lamprophyre dike
FLUORITE: Present in amygdules with quartz

056. SUNDAY (MONDAY FR.)
NTS 82N/7E, MINFILE No. 082N053, 51°19.7', 116°32.7'
DEPOSIT CLASS: Vein
COMMODITIES: Pb, Zn, Cu
HOSTROCKS: Calcareous slates and argillites
FLUORITE: Gangue mineral, together with calcite in veins and pockets up to 30 cm wide; white to greenish blue in colour

057. PORCUPINE CREEK
NTS 82N/7E, MINFILE No. 082N069, 51°17.7', 116°39.2'
DEPOSIT CLASS: Vein
COMMODITIES: Pb
HOSTROCKS: Dolomitic slate
FLUORITE: Gangue mineral, associated with muscovite and lepidomelane, in ankerite-galena-pyrite veins 2.5 to 12 cm wide

058. BRITANNIA (VICTORIA, FAIRVIEW, JANE, EMPRESS, BLUFF, NO. 10)
NTS 92G/11E, MINFILE No. 092GNW003, 49°36', 123°07.4'
DEPOSIT CLASS: Volcanogenic massive sulphide
COMMODITIES: Cu, Zn, Pb, Au, Ag
HOSTROCKS: Volcanic rocks of the Britannia pendant
FLUORITE: Trace amounts in the ore

059. CLAREMONT (ARGENTITE, TOP, FIX)
NTS 92H/16W, MINFILE No. 092HNE029, 49°46.4', 120°19.3'
DEPOSIT CLASS: Vein
COMMODITIES: Pb, Zn, Ag, Au
HOSTROCKS: Granitic rocks of the Siwash Creek body of the Otter intrusions
FLUORITE: Present in fine seams occupying joints in altered granite

060. *REDBIRD (MICROGOLD)
NTS 92I/8W, MINFILE No. 092ISE179, 50°23.5', 120°22.1'
DEPOSIT CLASS: Epithermal vein
COMMODITIES: Fluorite, Au
HOSTROCKS: Triassic Nicola Group volcanics
FLUORITE: Predominantly purple, some green varieties present; in veins from a few cm to a few m in width, associated with crystalline quartz and banded chalcedony; locally present in open spaces within veins as large well-formed crystals

061. *CINDY (MICROGOLD)
NTS 92I/8W, MINFILE No. 092ISE134, 50°23.2', 120°21.9'
DEPOSIT CLASS: Epithermal vein
COMMODITIES: Au, Cu, fluorite
HOSTROCKS: Triassic Nicola Group volcanics
FLUORITE: Purple or green; with calcite in many of the chalcedonic quartz veins

062. PYTHON (COPPERHEAD, MAKAOO, NOONDAY)
NTS 92I/9W, MINFILE No. 092INE002, 50°38.7', 120°23.6'
DEPOSIT CLASS: Porphyry Cu
COMMODITIES: Cu, Ag, Au, Mo
HOSTROCKS: Altered Triassic Nicola volcanics and intrusive diorites of the Ironmask batholith
FLUORITE: Minor; noted in cavities in mineralized rock

063. LUCKY JANE (LAKE SHORE)
NTS 92J/9W, MINFILE No. 092JNE110, 50°36.4', 122°26'
DEPOSIT CLASS: Igneous (fluorspar) adjacent to metamorphic (talc) deposit
COMMODITIES: Talc
HOSTROCKS: Miarolitic granite, intrusive into Coast Range batholith
FLUORITE: Accessory mineral in miarolitic cavities with quartz and potassium feldspar; miarolitic cavities extremely abundant

064. ANTICLIMAX (MO)
NTS 92P/9W, MINFILE No. 092P 015, 51°35.8, 120°18.2'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo, minor W
HOSTROCKS: Granite, Tuloon stock
FLUORITE: Present, but rare, in mineralized veins and stringers

065. HENDRIX LAKE (BOSS MOUNTAIN MINE)
NTS 93A/2W, MINFILE No. 093A 001, 52°05.9', 120°54.4
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo, minor Cu
HOSTROCKS: Quartz diorite breccia pipes, marginal phase of Takomkane batholith
FLUORITE: Minor or trace phase in quartz veins

066. **EAGLET
NTS 93A/10W, MINFILE No. 093A 046, 52°34.1, 120°59.5'
DEPOSIT CLASS: Greisen, replacement, vein
COMMODITIES: Fluorite
HOSTROCKS: Late Devonian Quesnel Lake gneiss and Cretaceous-Tertiary granites
FLUORITE: Purple, white, green, blue; massive veins and replacement zones; 1.8 million t of 15% CaF_2 outlined

067. RED BIRD (CAFB, OLD GLORY)
NTS 93E/6E, MINFILE No. 093E 026, 53°17.9', 127°00.5'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo, Cu
HOSTROCKS: Eocene quartz monzonite stock intrusive into Jurassic Hazelton Group pyroclastic rocks
FLUORITE: In late-stage veins outside the main mineralized zone, associated with calcite

068. MENTOR (CARIBOO, SUNSET)
NTS 93E/6E, MINFILE No. 093E 031, 53°27.5', 127°04.5'
DEPOSIT CLASS: Veins in shear zones
COMMODITIES: Zn, Cu, Pb
HOSTROCKS: Jurassic Hazelton Group tuffs
FLUORITE: Purple; forms thin encrustations on some fracture planes

069. *COLES
NTS 93E\6W, MINFILE No. 093E 110, 53°25', 127°17'
DEPOSIT CLASS: Epithermal veins in fault zones
COMMODITIES: Au, minor Ag, Cu, Pb, Zn
HOSTROCKS: Volcanic and sedimentary rocks of the Lower Jurassic Telkwa Formation, Hazelton Group
FLUORITE: Purple, green and colourless; locally common gangue mineral

070. HUCKLEBERRY (LEN)
NTS 93E/11E, MINFILE No. 093E 037 & 098, 053°40.9', 127°10.5'
DEPOSIT CLASS: Porphyry Cu-Mo
COMMODITIES: Cu, Mo
HOSTROCKS: Jurassic Hazelton Group volcanics and Late Cretaceous granodiorite porphyry stock
FLUORITE: Minor, in quartz veins

071. BERGETTE
NTS 93E/14W, MINFILE No. 093E 052, 53°47.8', 127°16.7'
DEPOSIT CLASS: Porphyry Cu-Mo
COMMODITIES: Cu, Mo
HOSTROCKS: Jurassic Hazelton Group volcanics and sediments, Sibola granitic stock
FLUORITE: Minor

072. BINTA LAKE
NTS 93F/14W, 53°54', 125°25'
DEPOSIT CLASS: Igneous
COMMODITIES: N/A
HOSTROCKS: Miarolitic granite intruding rhyolites and dacites of the Ootsa Lake Group
FLUORITE: Occurs in miarolitic cavities with quartz and feldspar

073. P.G. NIOBIUM (PRINCE, GEORGE, WICHEEDA LAKE, MORGANA)
NTS 93J/8, 9; 93I/5, MINFILE No. 093J 014; 122°00', 54°30'
DEPOSIT CLASS: Igneous
COMMODITIES: Nb, minor REE, Y
HOSTROCKS: Carbonatites and syenites of probable Mid-Paleozoic age
FLUORITE: Present as accessory mineral in narrow carbonatite dikes on the GEORGE grid (93J/9, 122°05', 54°31')

074. WAPITI EAST
NTS 93I/10E, MINFILE No. 093I 022, 54°31.9', 120°40'
DEPOSIT CLASS: Sedimentary phosphorite
COMMODITIES: Phosphate
HOSTROCKS: Phosphatic sandstone, Permian Mowitch Formation
FLUORITE: Minor; intergranular, in fluorapatite-rich beds

075. GROS (SAM)
NTS 93K/3W, MINFILE No. 093K 018, 54°04.3', 125°16.9'
DEPOSIT CLASS: Vein
COMMODITIES: (Explored for Mo, none found)
HOSTROCKS: Tertiary volcanics overlying quartz diorite of the Topley intrusions
FLUORITE: Present in quartz veinlets

076. MONA (NORTHERN LIGHT?)
NTS 93K/4E, MINFILE No. 093K 032, 54°06',125°43.8'
DEPOSIT CLASS: Vein
COMMODITIES: Ag, Pb, Zn, Cu
HOSTROCKS: Andesite
FLUORITE: Minor gangue mineral with barite and quartz

077. SAM GOOSLY (GOOSLY, S.G.)
NTS 93L/1W, MINFILE No. 093L 001, 54°11.1', 126°16.1'
DEPOSIT CLASS: Transitional Cu-Ag
COMMODITIES: Cu, Ag, Au, minor Pb, Zn
HOSTROCKS: Jurassic Hazelton Group dacitic tuffs intruded by a gabbro-syenomonzonite stock
FLUORITE: Conspicuous accessory mineral in sulphide zones

078. DEER (JULIAN MINES, MUD LAKE COPPER)
NTS 93L/7E, MINFILE No. 093L 011, 54°24.8', 126°34.2'
Deposit Class: Porphyry Cu
COMMODITIES: Cu, minor Pb, Zn
HOSTROCKS: Pyroclastic andesitic rocks of the Jurassic Hazelton Group, intruded by aplitic dikes

FLUORITE: Purple; trace amounts associated with Cu mineralization; widely distributed throughout the host volcanic rocks, even beyond the zone of mineralization

079. CUP (PROSTAR, HILLTOP, NEW HILL TOP, TIGLISH)
NTS 93L/7E, MINFILE No. 93L 203, 54°27.3', 126°39'
DEPOSIT CLASS: Porphyry Cu
COMMODITIES: Cu, Pb, Zn
HOSTROCKS: Fragmental volcanics, Jurassic Hazelton Group
FLUORITE: Purple; occurs as hairline fracture fillings with Cu minerals

080. HILLTOP 11 (HD, LEADER, GROUSE, CUP)
NTS 93L/7E, MINFILE No. 93L 205, 54°27.3', 126°39'
DEPOSIT CLASS: Syngenetic
COMMODITIES: Zn, Pb, Cu
HOSTROCKS: Chert interbeds in fragmental volcanics, Jurassic Hazelton Group
FLUORITE: Occurs as inclusions in honey-brown sphalerite

081. GLACIER GULCH MOLYBDENUM
NTS 93L/14W, MINFILE No. 093L 110, 54°49.2', 127°17.9'
DEPOSIT CLASS: Porphyry Mo-W
COMMODITIES: Mo, W, Cu
HOSTROCKS: Hazelton Group volcanics and intermediate to acidic intrusive rocks
FLUORITE: Trace

082. ROCHER DÉBOULÉ STOCK
NTS 93M/3W & 4E, 55°07.5', 127°30'
DEPOSIT CLASS: Igneous
COMMODITIES:N/A
HOSTROCKS: Porphyritic granodiorite and tonalite of the Cretaceous Rocher Déboulé stock
FLUORITE: Rare accessory mineral

083. AXEL (GOLDAXE)
NTS 093N/13W, MINFILE No. 093N 196, 55°57.9', 125°58.5'
DEPOSIT CLASS: Vein
COMMODITIES: Au, Pb, Cu, Sb, Zn
HOSTROCKS: Syenite porphyry, Axel intrusion
FLUORITE: In quartz veins, with stibnite and chalcopyrite

084. ALEY
NTS 94B/5, MINFILE No. 092B 027, 56°27', 126°44'
DEPOSIT CLASS: Igneous, carbonatite-related
COMMODITIES: Nb
HOSTROCKS: Devono-Mississippian carbonatite intrusion
FLUORITE: Accessory mineral (trace to a few %) in late-stage, rare earth element enriched dikes

085. GOLDEN LION
NTS 94E/11W, MINFILE No. 094E 077, 57°33.2', 127°16.5'
DEPOSIT CLASS: Vein
COMMODITIES: Pb, Zn, Cu, Ag
HOSTROCKS: Andesitic and dacitic tuffs, Toodoggone volcanics
FLUORITE: Bright green; associated with quartz in an alteration zone

086. EGG (FOO, REDFERN LAKE)
NTS 94G/5W, MINFILE No. 094G 002 & 018, 57°22.2', 123°51.5'
DEPOSIT CLASS: Carbonate-hosted Pb-Zn
COMMODITIES: Pb, Zn
HOSTROCKS: Middle Devonian Dunedin Formation carbonates and Besa River Formation shales
FLUORITE: Minor, associated with sphalerite, barite, minor galena and rare copper mineralization in stratabound breccias and veins

087. BE
NTS 94G/5W, MINFILE No. 094G 012, 57°22.3', 123°58.9'
DEPOSIT CLASS: Carbonate-hosted Pb-Zn
COMMODITIES: Pb
HOSTROCKS: Middle Devonian Dunedin Formation carbonates
FLUORITE: Associated with barite and galena

088. CAY
NTS 94G/13W, MINFILE No. 094G 017, 57°46.8', 123°56.4'
DEPOSIT CLASS: Carbonate-hosted Pb-Zn
COMMODITIES: Zn, Pb, Ge, Ga
HOSTROCKS: Middle Devonian Dunedin Formation carbonates
FLUORITE: Colourless to pale purple; minor accessory gangue mineral with calcite and barite, associated with galena and lesser sphalerite replacement pods and breccia infillings

089. OCCURRENCE
NTS 94K/7W, 5819', 124°47'
DEPOSIT CLASS: Carbonate-hosted Ba-F
COMMODITIES: Ba
HOSTROCKS: Middle Devonian Dunedin Formation
FLUORITE: Accessory, with barite

090. *HOPE (HOPE 3, CBC)
NTS 94K/8W, MINFILE No. 094K 063, 58°19', 124°19.9'
DEPOSIT CLASS: Carbonate-hosted Pb-Zn
COMMODITIES: Zn
HOSTROCKS: Middle Devonian Dunedin Formation carbonates
FLUORITE: Common in barite-calcite-galena veins and stringers which locally contain red sphalerite

091. CTV (DODO)
NTS 94K/8W, MINFILE No. 094K 006, 58°23.7', 124°23'
DEPOSIT CLASS: Carbonate-hosted Pb-Zn
COMMODITIES: Pb, Zn
HOSTROCKS: Devonian Stone and Dunedin Formation carbonates
FLUORITE: Accessory, associated with barite, galena and sphalerite disseminated in the sediments and as stringers and pods

092. *MILE 397 BARITE (Lot 2198, BAR, ONE TEN CREEK)
NTS 94K/10W, MINFILE No. 094K 004, 58°40.6', 124°46.7'

DEPOSIT CLASS: Carbonate-hosted Ba-F
COMMODITIES: Ba
HOSTROCKS: Middle Devonian Nahanni Formation (Dunedin equivalent)
FLUORITE: Dark purple; abundant, associated with barite and calcite in replacement pods and open space filling in stratabound breccia zones

093. OCCURRENCE
NTS 94K/10W, 58°43', 124°45.5'
DEPOSIT CLASS: Carbonate-hosted Ba-F
COMMODITIES: Ba
HOSTROCKS: Middle Devonian Dunedin Formation
FLUORITE: Accessory, with barite

094. MUNCHO LAKE
NTS 94K\13W, MINFILE No. 094K 038, 58°56.3', 125°56.3'
DEPOSIT CLASS: Carbonate-hosted Ba-F
COMMODITIES: Ba
HOSTROCKS: Middle Devonian Dunedin Formation
FLUORITE: Relatively common in veins, with barite

095. OCCURRENCE
NTS 94K/15W, 58°45.5', 124°48'
DEPOSIT CLASS: Carbonate-hosted Ba-F
COMMODITIES: Ba
HOSTROCKS: Middle Devonian Dunedin Formation
FLUORITE: Accessory, with barite

096. *KECHIKA YTTRIUM (RAR, REE & REO CLAIMS, DALL LAKE)
NTS 94L/11W, 12E & 13E, MINFILE No. 094L 008, 009 & 015, 58°42', 127°31'
DEPOSIT CLASS: Igneous, syenite-carbonatite related
COMMODITIES: Y, REE
HOSTROCKS: Carbonatites, mafic syenite (malignites), igneous breccias and alteration zones
FLUORITE: Medium to dark purple; occurs with calcite±epidote and biotite in coarse-grained veins in malignites, as disseminations with pyrite in carbonatite dikes and igneous breccias, in fine-grained pyrite-calcite±biotite veins and associated with pyrite in the matrix of sedimentary breccias adjacent to trachyte dikes

097. **GEM (GEM A, B, C, D, F; LIARD FLUORSPAR)
NTS 94M/8E, MINFILE No. 094M 002, 59°26.9', 126°05.1'
DEPOSIT CLASS: Carbonate-hosted fluorite-witherite-barite
COMMODITIES: Fluorite, witherite, barite
HOSTROCKS: Middle Devonian Dunedin Formation carbonates
FLUORITE: Colourless to pink to dark purple; associated with barite and witherite in replacement bodies and breccia infillings

098. *GEM E (LIARD FLUORSPAR)
NTS 94M/8E, MINFILE No. 094M 015, 59°26.9', 126°06.1'
DEPOSIT CLASS: Carbonate & shale-hosted fluorite-witherite-barite
COMMODITIES: Fluorite, witherite, barite
HOSTROCKS: Middle Devonian Besa River shales immediately overlying Dunedin Formation carbonates
FLUORITE: Colourless to purple; associated with barite and other barium minerals in veinlets, replacement bodies and breccia infillings in shale

099. *BAR (LIARD FLUORSPAR; THOR GROUP)
NTS 94M\8E, MINFILE No. 094M 013, 59°29.1', 126°05.5'
DEPOSIT CLASS: Carbonate-hosted fluorite-barite
COMMODITIES: Fluorspar
HOSTROCKS: Middle Devonian Dunedin Formation limestones
FLUORITE: High-grade fluorspar mineralization occurs with barite in massive but discontinuous replacement pods, veins and disseminations

100. *HENRY (LIARD FLUORSPAR; THOR GROUP)
NTS 94M/8E; MINFILE No. 094M 014, 59°28.7', 126°05.6'
DEPOSIT CLASS: Carbonate-hosted fluorite-witherite-barite
COMMODITIES: Fluorite, witherite, barite
HOSTROCKS: Middle Devonian Dunedin Formation limestones
FLUORITE: Associated with witherite and barite, replacing limestone

101. **TAM (LIARD FLUORSPAR, THOR GROUP)
NTS 94M/9E, MINFILE No. 094M 005, 59°32', 126°04.4'
DEPOSIT CLASS: Carbonate-hosted fluorite-witherite
COMMODITIES: Fluorite, witherite
HOSTROCKS: Middle Devonian Dunedin Formation carbonates and Besa River shales
FLUORITE: Dark purple to black; associated with witherite and barite in replacement bodies and breccia fillings in carbonates and, to a lesser extent, shales; mineralized zone approximately 300 m by 50 to 165 m in area

102. *FIRE (LIARD FLUORSPAR; THOR GROUP)
NTS 94M/9E, MINFILE No. 094M 006, 59°30.9', 126°07.1'
DEPOSIT CLASS: Carbonate and shale-hosted fluorite-witherite
COMMODITIES: Fluorite, witherite
HOSTROCKS: Middle Devonian Dunedin Formation carbonates and Besa River shales
FLUORITE: Purple; associated with witherite in limestone and shale breccias

103. **CORAL (LIARD FLUORSPAR; THOR GROUP)
NTS 94M/9E, MINFILE No. 094M 007, 59°33.7', 126°05.1'
DEPOSIT CLASS: Carbonate and shale-hosted fluorite-witherite-barite
COMMODITIES: Fluorite, witherite, barite
HOSTROCKS: Middle Devonian Dunedin Formation carbonates
FLUORITE: Purple; associated with barite and witherite in replacement bodies and breccia fillings in limestone and, to a lesser extent, in the overlying shales; one drill-hole intersected 26.5 m of 39% CaF_2

104. *CAMP (LIARD FLUORSPAR; THOR GROUP)
NTS 94M/9E, MINFILE No. 094M 008, 59°33.7', 126°05.1'

DEPOSIT CLASS: Carbonate and shale-hosted fluorite-witherite-barite
COMMODITIES: Fluorite, witherite, barite
HOSTROCKS: Middle Devonian Dunedin Formation carbonates and Besa River shales
FLUORITE: Purple; associated with barite and witherite in limestone and shale breccias

105. **TEE (LIARD FLUORSPAR; THOR 8 & 9)
NTS 94M/9E, MINFILE No. 094M 010, 59°34.5', 126°05.2'
DEPOSIT CLASS: Carbonate and shale-hosted fluorite-witherite-barite
COMMODITIES: Fluorite, witherite, barite
HOSTROCKS: Middle Devonian Dunedin Formation carbonates and Besa River shales
FLUORITE: Distributed in four mineralized zones; Zone A has a surface area of approximately 100 x 65 m and consists of predominantly colourless fluorspar associated with barite and witherite replacing limestone; Zones B and C consist of veins and replacement lenses of fluorite in limestone and shale breccias; Zone D consists of veins and infillings of barium minerals and some fluorspar in shale and shale breccia

106. *STRAP (LIARD FLUORSPAR)
NTS 94M/9E, MINFILE No. 094M 011, 59°35.1', 126°07.2'
DEPOSIT CLASS: Carbonate-hosted fluorite-barite
COMMODITIES: Fluorite, barite
HOSTROCKS: Middle Devonian Dunedin Formation carbonates
FLUORITE: Associated with barite in replacement bodies and breccia infillings; one mineralized zone, 7 x 7.5 m in area, contains 28.6% CaF_2

107. NICK (LIARD FLUORSPAR)
NTS 94M/9E, MINFILE No. 094M 012, 59°31.8', 126°09.2'
DEPOSIT CLASS: Shale-hosted fluorite
COMMODITIES: Fluorite, barium
HOSTROCKS: Middle Devonian Besa River shales
FLUORITE: Fluorite and barium minerals occur in sparse fractures in shale breccia

108. TEASER (LIARD FLUORSPAR)
NTS 94M/9E, 59°31', 126°05'
DEPOSIT CLASS: Carbonate-hosted fluorite
COMMODITIES: Fluorite, barium
HOSTROCKS: Middle Devonian Dunedin Formation limestones
FLUORITE: Scarce; associated with witherite and baritocalcite

109. PEG
NTS 94M/12E, 59°34', 127°40'
DEPOSIT CLASS: Vein
COMMODITIES: Zn, Cu
HOSTROCKS: Argillaceous limestones, Cambrian Kechika Group
FLUORITE: Gangue mineral with barite, in veins containing tetrahedrite and sphalerite

110. *SNOW
NTS 94N/4E, MINFILE No. 094N 003, 59°04.6', 125°39'
DEPOSIT CLASS: Carbonate-hosted fluorite
COMMODITIES: Fluorspar
HOSTROCKS: Middle Devonian Dunedin Formation limestones
FLUORITE: Replacements and fracture filling; average grades of 18% CaF_2 in zones with surface exposures of approximately 76 x 24 and 90 x 35 m

111. *DAN (JOY, STAN, SUN, TOM)
NTS 94N/11W & 12E, MINFILE No. 094N 004, 005 & 006, 59°41.8', 125°28.5'
DEPOSIT CLASS: Carbonate-hosted fluorite-barite-witherite
COMMODITIES: Fluorspar, barite, witherite
HOSTROCKS: Middle Devonian Dunedin Formation limestones
FLUORITE: Colourless and purple; occurs with barite, witherite and calcite as bedded replacements up to 10 m thick, in veins up to 1 m in width, as breccia infillings and as disseminations; 12 separate showings on the property

112. BOW (PETE, RAE)
NTS 94N/13E & 14W, 59°52.9', 125°26.5'
DEPOSIT CLASS: Carbonate-hosted fluorite
COMMODITIES: Fluorite
HOSTROCKS: Middle Devonian Dunedin Formation limestones
FLUORITE: Occurs in bedded replacement bodies

113. SEVEN SISTERS MOUNTAIN RANGE (BIG OLIVER, MARGARITE, REGA, MAG, JACKAL, CALEDONIA, WAVERLY, MOLYBDENITE)
NTS 103I/16E & 103P/1E, MINFILE No. 103I-J 055, 056, 128, 129, 149, 150, 54°55' to 55°02', 128°06 to 14'
DEPOSIT CLASS: Porphyry Mo-Cu-W
COMMODITIES: Mo, W, Cu, minor Pb, Zn, Au
HOSTROCKS: Granodiorite and quartz monzonite of the Coast complex and Bowser Group sediments
FLUORITE: Associated with molybdenite, pyrite and scheelite; traces of mineralization scattered over large areas

114. BC MOLY (LIME CREEK, ALICE, LYNX, CARIBOU, MOHAWK MOUNTAIN)
NTS 103P/6W, MINFILE No. 103P 120, 55°23.5',129°25.5'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo
HOSTROCKS: Siltstones and greywackes of Late Jurassic to Early Cretaceous age, cut by alaskite, quartz monzonite and quartz diorite of the Tertiary Alice Arm intrusions
FLUORITE: Purple; minor; in quartz veins with galena, sphalerite, cosalite, scheelite and minor chalcopyrite, in quartz-pyrite veins and disseminated with molybdenite

115. SURPRISE CREEK (SURPRISE, SUR)
NTS 104A/4E, MINFILE No. 104A 080, 56°14', 129°33'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo, Ag
HOSTROCKS: Porphyritic granodiorite to quartz monzonite stock intruding sedimentary rocks of the Bowser Group
FLUORITE: Purple; accessory mineral in altered intrusive rocks

116. TAMI (BLUE RIBBON, SNIP 2, SERICITE RIDGE)
NTS 104B/10W, MINFILE No. 104B 116, 56°35.1', 130°52.8'
DEPOSIT CLASS: Porphyry Cu
COMMODITIES: Au, Ag, Cu, Pb
HOSTROCKS: Dioritic rocks of the Coast plutonic complex intrusive into andesitic tuffs, greywackes and siltstones of the Stuhini Group or Unuk River Formation, Hazelton Group
FLUORITE: In gypsum-calcite veins with traces of copper mineralization

117. COPPER CANYON (PENNY, CC)
NTS 104G/3W, MINFILE No. 104G 017, 57°07', 131°20.7'
DEPOSIT CLASS: Alkaline porphyry Cu
COMMODITIES: Cu, Au, Ag
HOSTROCKS: Syenite, Galore Creek stock
FLUORITE: Minor, disseminated

118. GALORE CREEK
NTS 104G/3W, MINFILE No. 104G 100, 57°08', 131°28'
DEPOSIT CLASS: Alkaline porphyry Cu
COMMODITIES: Cu
HOSTROCKS: Syenite porphyry, Galore Creek stock
FLUORITE: Minor; disseminated and in veins; associated with chalcopyrite, molybdenite, pyrite, magnetite, hematite and locally barite, gypsum and anhydrite

119. MT. OGDEN (MOLY-TAKU, NAN, PAT)
NTS 104K/6W, MINFILE No. 104K 013, 58°26.3', 133°21.5'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo, Zn, Cu, Ag, W
HOSTROCKS: Alaskite intrusive into argillites, limestones and greenstones
FLUORITE: Present in alteration selvages of molybdenite veins with quartz, sericite, biotite, pyrite and locally, sphalerite; also present in quartz-chlorite-rhodochrosite-scheelite veins

120. MOLY-TAKU Y ZONE
NTS 104K/6W, MINFILE No. 104K 047, 58°26.1', 133°20.7'
DEPOSIT CLASS: Porphyry Mo-W
COMMODITIES: Mo, W, Zn, Cu
HOSTROCKS: Alaskite intrusive into argillites and greenstones
FLUORITE: Accessory mineral within the alaskite; also present in veins in molybdenite-scheelite mineralized zones

121. LC 1 (PETER, FOOL)
NTS 104K/7E, MINFILE No. 104K 026, 58°20.4', 132°41.9'
DEPOSIT CLASS: Vein
COMMODITIES: Mo, Cu, Ag, W
HOSTROCKS: Quartz feldspar porphyry dikes intrusive into Triassic diorite and quartz-diorite
FLUORITE: In quartz veins with molybdenite, pyrite, chalcopyrite, magnetite and minor scheelite, stibnite and powellite

122. KOWATUA CREEK LIMESTONE
NTS 104K/7E & 8W, MINFILE No. 104K 070, 58°28.9', 132°28.7'
DEPOSIT CLASS: Sedimentary
COMMODITIES: Limestone
HOSTROCKS: Upper Triassic Sinwa Formation limestone
FLUORITE: In veinlets in altered, silicified limestone above the King Salmon thrust fault

123. "TARDIS (PETRO, KOWATUA CREEK)
NTS 104K/10E, MINFILE No. 104K 112, 58°39.1', 132°33.5'
DEPOSIT CLASS: Vein
COMMODITIES: Fluorite
HOSTROCKS: Upper Triassic Sinwa Formation limestone
FLUORITE: Colourless, honey, purple and blue; in veinlets in intensely altered, silicified and brecciated limestone above the King Salmon thrust fault

124. BS-J
NTS 104K/10W, MINFILE No. 104K 029, 58°30.5', 132° 56.22'
DEPOSIT CLASS: Porphyry Cu-Mo
COMMODITIES: Cu, Mo
HOSTROCKS: Cretaceous-Tertiary quartz monzonite intrusive into Mesozoic sedimentary and volcanic rocks
FLUORITE: Disseminated in biotite-hornblende quartz monzonite, together with specularite, magnetite, chalcopyrite and molybdenite

125. TULSEQUAH CHIEF (MANVILLE, BIG BULL, A.E.COFFMAN)
NTS 104K/12E, MINFILE No. 104K 002, 58°44.5', 133°35'
DEPOSIT CLASS: Volcanogenic massive sulphide (Kuroko type)
COMMODITIES: Cu, Pb, Zn, Au, Ag
HOSTROCKS: Triassic volcanics and felsic dikes, Stuhini Group
FLUORITE: Reported from quartz-calcite veins cross-cutting host volcanic rocks

126. SILT
NTS 104M/13E, MINFILE No. 104M 054, 59°58', 135°36.8'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo, minor Zn, Pb, Cu, Sn
HOSTROCKS: Alaskite to quartz monzonite, Coast plutonic complex
FLUORITE: Trace; in veins with molybdenite, sphalerite, chalcopyrite and cassiterite

127. RIO CREEK
NTS 104M/13E, MINFILE No. 104M 056, 59°57.5', 135°35.9'
DEPOSIT CLASS: Vein
COMMODITIES: Zn, Pb, Cu, Sn
HOSTROCKS: Alaskite and leucocratic quartz monzonite, Coast plutonic complex
FLUORITE: Lining fractures together with sphalerite, galena, chalcopyrite and cassiterite

128. JONES
NTS 104M/14W, MINFILE No. 104M 060, 59°58', 135°19.3'
DEPOSIT CLASS: Vein
COMMODITIES: U, Cu, Pb, Zn
HOSTROCKS: Quartz monzonites of the Coast plutonic complex, Eocene Skukum Group rhyolites (Bennett Lake caldera complex)
FLUORITE: Trace; in quartz veins with chalcopyrite, sphalerite and galena near radioactive pegmatite dikes

129. BOOT (LINE, STORM, WINDY, NI, FIRE)
NTS 104N/7W & 10W, MINFILE No. 104N 078, 59°31', 132°50'
DEPOSIT CLASS: Porphyry Mo (Cu-W)
COMMODITIES: Mo, minor Cu, W, Pb, Zn, Sn
HOSTROCKS: Cherts, argillites and limestones of the Cache Creek Group, intruded by leucogranite to alaskite stock
FLUORITE: Present in replacement lenses in limestone and in quartz veins and fractures associated with molybdenite, chalcopyrite, galena, sphalerite, wolframite and cassiterite

130. ZENAZIE (WHI 357)
NTS 104N/10W, MINFILE No. 104N 065, 59°43.3', 132°56.8'
DEPOSIT CLASS: Vein
COMMODITIES: W, minor Mo, Cu, Be
HOSTROCKS: Alaskite, Surprise Lake batholith
FLUORITE: Trace, in quartz-molybdenite-wolframite veins with minor beryl

131. CANDY (WHI 147)
NTS 104N/10W, MINFILE No. 104N 066, 59°40.1', 132°56.2'
DEPOSIT CLASS: Porphyry Mo-W-Cu
COMMODITIES: Mo, lesser W and Cu
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite porphyry, Surprise Lake batholith
FLUORITE: In fractures and quartz veins with molybdenite, wolframite, chalcopyrite and beryl

132. CY (ENG, WEIR MOUNTAIN)
NTS 104N/10W, MINFILE No. 104N 089, 59°39', 132°59'
DEPOSIT CLASS: Porphyry U-W-Mo
COMMODITIES: U, W, Mo, Pb, Zn (anomalous Y also reported)
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite of the Surprise Lake batholith
FLUORITE: Purple fluorite and beryl occur in quartz veins; minor fluorite also disseminated in mineralized zones; topaz also reported

133. SURPRISE LAKE BATHOLITH
NTS 104N/10 & 11, 59°45', 133°10'
DEPOSIT CLASS: Igneous
COMMODITIES: N/A
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite, Surprise Lake batholith
FLUORITE: Widespread trace mineral; topaz rare

134. MONT (DIXIE)
NTS 104N/11E, MINFILE No. 104N 086, 59°36.1', 133°11'
DEPOSIT CLASS: Vein
COMMODITIES: U
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite, Surprise Lake batholith
FLUORITE: Minor, associated with U mineralization

135. D & D (DAVE)
NTS 104N/11E, MINFILE No. 104N 108, 59°45.8', 133°16.3'
DEPOSIT CLASS: Vein
COMMODITIES: U, Cu, Pb, Zn, W
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite, Surprise Lake batholith
FLUORITE: Minor; associated with chalcopyrite, galena, sphalerite, wolframite and minor uranium mineralization

136. QUARTZ CREEK (D & D)
NTS 104N/11E, MINFILE No. 104N 128, 59°38', 133°08.9'
DEPOSIT CLASS: Porphyry Cu-W
COMMODITIES: Cu, Pb, Zn, W
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite, Surprise Lake batholith
FLUORITE: Minor; associated with minor disseminated chalcopyrite, galena, sphalerite and wolframite

137. PURPLE ROSE (FISHER, CRACKER CREEK URANIUM)
NTS 104N/11W, MINFILE No. 104N 005, 090, 59°43.5', 133°18.8'
DEPOSIT CLASS: Vein
COMMODITIES: U
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite, Surprise Lake batholith
FLUORITE: In narrow stringers associated with U mineralization

138. ADANAC (ADERA, HOBO 7, EMIL, KEY)
NTS 104N/11W, MINFILE No. 104N 052, 59°42.6', 133°24.2'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo
HOSTROCKS: Late Cretaceous or Early Tertiary quartz monzonite porphyry and alaskite, Surprise Lake batholith, intrusive into Cache Creek Group metavolcanic rocks
FLUORITE: Abundant accessory in quartz monzonite porphyry; major accessory mineral in alteration halo

139. *SILVER DIAMOND
NTS 104N/11W, MINFILE No. 104N 069, 59°40', 133°26.4'
DEPOSIT CLASS: Sn-F skarn
COMMODITIES: Sn
HOSTROCKS: Skarn, adjacent to Surprise Lake batholith
FLUORITE: In skarn, with pyrrhotite

140. LISLE (SURPRISE)
NTS 104N/11W; MINFILE No. 104N 076, 59°40', 133°21'
DEPOSIT CLASS: Vein
COMMODITIES: Cu, minor W
HOSTROCKS: Late Cretaceous or Early Teritary alaskite, Surprise Lake batholith

FLUORITE: Trace; associated with chalcopyrite and wolframite in quartz-sericite-clay-altered shear zone

141. SERA (SURPRISE)
NTS 104N/11W; MINFILE No. 104N 076, 59°37', 133°20'
DEPOSIT CLASS: Uncertain
COMMODITIES: N/A
HOSTROCKS: Cache Creek Group volcanic and sedimentary rocks intruded by Late Cretaceous or Early Teritary alaskite of the Surprise Lake batholith
FLUORITE: Trace

142. WMC
NTS 104N/11W, MINFILE No. 104N 093, 59°43', 133°16'
DEPOSIT CLASS: Vein
COMMODITIES: U (minor W, Be, Cu, Mo)
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite, Surprise Lake batholith
FLUORITE: Minor component of quartz veins with arsenopyrite, chalcopyrite, molybdenite and beryl

143. MISTAKE
NTS 104N/11W, MINFILE No. 104N 107, 59°44.9', 133°18'
DEPOSIT CLASS: Vein
COMMODITIES: Ag, U, Au, Pb
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite, Surprise Lake batholith
FLUORITE: In quartz veins with minor arsenopyrite, galena, sphalerite, chalcopyrite and possibly, zeunerite, hosted by a shear zone

144. HUSSELBEE (BEAVER)
NTS 104N/12W, MINFILE No 104N 001, 59°42.2', 133°51.9'
DEPOSIT CLASS: Skarn
COMMODITIES: U, Th
HOSTROCKS: Quartzites and metavolcanic rocks of the Cache Creek Group, intruded by granitic rocks of the Cretaceous Fourth of July stock
FLUORITE: Occurs with uranium minerals, pyrite and galena in a jasperoid skarn

145. IRA
NTS 104N/14W, MINFILE No. 104N 088, 59°41', 133°46'
DEPOSIT CLASS: Vein
COMMODITIES: U
HOSTROCKS: Late Cretaceous or Early Tertiary alaskite and quartz monzonite, Surprise Lake batholith
FLUORITE: Accessory mineral in alaskite, with beryl and rare topaz; also colourless, green, purple and dark purple varieties form veins, either alone or with quartz

146. AUGUST (NORTH CIRQUE, BEN, ZIP)
NTS 104O/5E, MINFILE No. 104O 026, 59°20.8', 131°34.9'
DEPOSIT CLASS: Vein (metals); Igneous (fluorite)
COMMODITIES: Ag, Pb, Zn, Cu, minor Sn, Be
HOSTROCKS: Cherts, argillites and quartzites of the Permo-Carboniferous Kekahda Formation intruded by granites and quartz diorite dikes and sills related to the Christmas Creek batholith
FLUORITE: Abundant, in granitic rocks in the vicinity of mineralized veins

147. MLM
NTS 104O/5E, 59°22', 131°40'
DEPOSIT CLASS: Vein
COMMODITIES: N/A
HOSTROCKS: Argillites and quartzites of the Kedahda Formation intruded by granitic rocks of the Glundebery batholith
FLUORITE: Minor, in quartz veins with epidote

148. *ASH MOUNTAIN
NTS 104O/7E & 8W, 59°18', 130°30.5'
DEPOSIT CLASS: Sn-F-skarn (wrigglite)
COMMODITIES: Sn, F
HOSTROCKS: Metasedimentary rocks adjacent to quartz monzonites of the Parallel Creek batholith
FLUORITE: Up to 13.9% F in skarn, with Sn and Be-enriched vesuvianite

149. SHAR 6
NTS 104O/11W, MINFILE No. 104O 051, 5939°, 131°08'
DEPOSIT CLASS: Sedimentary, shale-hosted
COMMODITIES: U, Cu
HOSTROCKS: Carboniferous graphitic shales
FLUORITE: Present; shales contain to 0.125 per cent F

150. GAZOO (TOOZAZA CREEK)
NTS 104O/9E, MINFILE No. 104O 027, 59°37', 130°12'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo
HOSTROCKS: Cretaceous (?) quartz monzonite; pale green beryl is present in quartz veins and related pegmatites
FLUORITE: Purple; common in calcite-chalcedony veins and less common in quartz-pyrite-sericite-molybdenite veins that occupy a northwest-trending fault zone

151. GAZOO-CENTRAL STOCK (TOOZAZA CREEK)
NTS 104O/9E, MINFILE No. 104O 044, 59°37.7', 130°13.8'
DEPOSIT CLASS: Vein
COMMODITIES: Mo, Cu
HOSTROCKS: Biotite-muscovite quartz monzonites in fault contact with foliated biotite quartz monzonite
FLUORITE: Present in calcite-chalcedony veins along fault contacts

152. *BLUE LIGHT
NTS 104O/9W, MINFILE No. 104O 005, 59°38.5', 130°27'
DEPOSIT CLASS: Skarn
COMMODITIES: W, Sn
HOSTROCKS: Roof pendant of augen gneiss in granites and quartz monzonites
FLUORITE: Occurs with scheelite, pyrite, pyrrhotite and minor chalcopyrite, magnetite and molybdenite in skarn; also, colourless variety present forming colloform masses and as vug linings in breccias formed in muscovite quartz monzonite

153. JENNINGS RIVER
NTS 104O 13E, MINFILE No. 104O 028, 59°59.5', 131°36'
DEPOSIT CLASS: Vein
COMMODITIES: N/A

HOSTROCKS: Granitic rocks of the Seagull Creek batholith intruding argillites and limestones
FLUORITE: Accessory mineral in quartz± wolframite veins cutting beryl-bearing granitic dikes

154. LOGJAM CREEK (LOGTUNG)
NTS 104O/13E, MINFILE No. 104O 016, 59°59.5', 131°37'
DEPOSIT CLASS: Porphyry Mo-W, some skarn
COMMODITIES: Mo, W, Sn
HOSTROCKS: Porphyritic alaskite and quartz monzonite of the Seagull Creek batholith and hornfelsed and skarned metasedimentary rocks of the Dorsey Group
FLUORITE: Purple; widespread; locally associated with molybdenum, tungsten and tin mineralization in a tourmaline-stockwork breccia pipe

155. LOW GRADE (NEEDLEPOINT MOUNTAIN)
NTS 104P/4W, MINFILE No. 104P 026, 59°08', 129°46.4'
DEPOSIT CLASS: Skarn (some wrigglite?)
COMMODITIES: Be, Sn, Fe
HOSTROCKS: Impure limestones in contact with granitic rocks of the Cassiar batholith
FLUORITE: Present in irregular patches in skarn

156. M (HUNTSMAN, CANADA GIRL)
NTS 104P/4W, MINFILE No. 104P 037, 59°14.9', 129°50.8'
DEPOSIT CLASS: Porphyry Mo-W
COMMODITIES: Mo, W
HOSTROCKS: Early Cretaceous quartz monzonite, Cassiar stock, in contact with Lower Cambrian Atan Group metasedimentary rocks
FLUORITE: Disseminations and fracture fillings with molybdenite, sericite, pyrite, gypsum and quartz

157. STORIE (CASMO)
NTS 104P/4W, MINFILE No. 104P 069, 59°14', 129°52'
DEPOSIT CLASS: Porphyry Mo
COMMODITIES: Mo
HOSTROCKS: Quartz feldspar porphyry, intrusive into the Cassiar batholith
FLUORITE: Accessory; occurs with coarse-grained muscovite in fractures

158. KUHN (WINDY)
NTS 104P/5W, MINFILE No. 104P 071, 59°21', 129°51.9'
DEPOSIT CLASS: Skarn
COMMODITIES: W, Mo
HOSTROCKS: Carbonates, Good Hope and Upper Atan groups, adjacent to Early Cretaceous quartz monzonites of the Cassiar stock
FLUORITE: Accessory, in garnet-diopside-actinolite-powellite skarn

159. DEAD GOAT (BALSAM)
NTS 104P/5W, MINFILE No. 104P 079, 59°20.4', 129°52.7'
DEPOSIT CLASS: Skarn
COMMODITIES: W, Cu, Zn, Mo
HOSTROCKS: Carbonates, Late Proterozoic Ingenika Group, adjacent to Early Cretaceous quartz monzonites of the Cassiar stock
FLUORITE: Accessory, in pyrrhotite-actinolite skarn layers containing pyrite, sphalerite, chalcopyrite and scheelite within larger garnet-skarn zones

160. *MOUNT REED (DOME)
NTS 104P/6W, MINFILE No. 104P 043, 59°18', 129°27.2'
DEPOSIT CLASS: Skarn (wrigglite)
COMMODITIES: W, Mo, minor Ag, Pb, Zn
HOSTROCKS: Carbonate rocks, Lower Cambrian Atan Group adjacent to Eocene Mount Reed magnetite-bearing granitic stock
FLUORITE: Minor but persistent constituent of skarn; fluorine contained in chondrodite accounts for the majority of fluorine-enrichment in F-Be and F-magnetite-rich inner skarns

161. HASKIN MOUNTAIN NORTHWEST (SNOW, JOEM, MOLY ZONE)
NTS 104P/6W, MINFILE No. 104P 059, 020, 59°20', 129°30'
DEPOSIT CLASS: Skarn
COMMODITIES: W, Mo, minor Sn, Ag, Pb, Zn
HOSTROCKS: Carbonate rocks, Lower Cambrian Atan Group adjacent to Eocene Mount Haskins magnetite-bearing granitic stock
FLUORITE: Minor but persistent constituent of pyrrhotite skarn

MAPS
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